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NEOCENE RECORD IN THE TEMBLOR BASIN, CALIFORNIA, AND NEOCENE DEPOSITS OF THE SAN JUAN DISTRICT, SAN LUIS OBISPO COUNTY.

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CONTENTS

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Introduction

The Question of the Monterey.—For more than the last ten years California geologists have been accustomed to the use of the term *Monterey Shales,* or *Monterey Formation,* as designating a somewhat definite formational division of the California Miocene, and as belonging to an equally definite time division of that period.

While the full discussion of this interesting question can not be undertaken within the limits of the present paper, there are some reflections that may be offered as prefatory to the subject. If the Miocene strata of California are capable of being consistently subdivided, it should be done, for purposes of intensive study and discussion, if for no other particular object.

The aggregate thickness of the entire Miocene section in California is very great, and the time interval represented is correspondingly long. In many localities in the Coast Ranges the Miocene strata attain or approach a thickness of 7000 feet, and the time required for such a body of strata, largely organic shales, to be deposited is too great to be included in a single time unit if any satisfactory divisions can be found.

While the Miocene deposits of California have not been extensively studied, they are well known to be locally complicated. The exact number and importance of these complications is not yet known.

Undoubtedly the criteria for the final subdivision of this stratigraphic series should begin with the larger events of its physical history. Faunal changes are, of course, important, but they are more likely to be controlled, or influenced, by the physical events, and are therefore of secondary diagnostic value. Next in importance for such purposes is, perhaps, lithology, and lastly, inference, theory, and scientific imagination.

In many cases the order of these criteria has undoubtedly been reversed, and lithology and imagination have been given prominence at the expense of the diastrophic record. The varied conditions of environment in which the faunas of the Miocene were developed, the great variety and composition of sediments, and the complicated physical history of the California Miocene, all contribute to the aggregate of variety that is met with in the field and in the literature.

While it will be admitted by all thoughtful geologists,—and the idea is by no means new—that lithology can form no proper basis for subdivision of the Miocene, still the thick group of strata of this period, showing as it does the signs of widespread disturbances, can not be considered as being overburdened by formational names when four or five have been proposed. In the early stages of stratigraphic study, if it is at all intensive, such names are necessary and should be welcomed when it seems necessary to the workers in the subject to make them, and they should not be discarded without a proper consideration, nor until shown by creditable authority to be unnecessary. It may be frankly admitted by the advocates of intensive stratigraphic study, without loss to their ideals, that mistakes have been made in the early stages of their work, but this fact should not discourage endeavor to find the order that undoubtedly exists in their subject. The solution of the problem, though not yet complete, is possible; and, if later investigators have erred in their search for proper criteria of differentiation, their endeavors have been toward advancement, and their success, though partial, should be welcomed and encouraged. Their errors, even if great, as they have not been, are no greater than the errors of earlier writers, and if pointed out, may still be amended.

But the difficulties in the way of making a systematic study and a systematic classification of strata should not of themselves discourage effort, nor can the difficulties inherent in the language of science be properly urged as a reason for the rejection of its results. As an example of a regrettable attitude, a recent writer has spent much effort to show that lithology can not form a sound basis of classification, and it is asserted by him that this has usually been the basis among previous writers. This author then proceeds to discourage attempts at subdivision, and endeavors to defend excathedra statements and conclusions that were on the face of them premature, and made before all the facts were known.

It has long been known that organic siliceous shales, such as occur near the town of Monterey, are a "depositional facies" that perhaps belongs to deep-water areas, and that strata of this type occur in nearly all parts of the Miocene in California, and, in fact, are not confined to the Miocene. The suggestion that this lithologic type is not serviceable for stratigraphic divisions, except locally, is not at all new. Dr. G. D. Louderback has recently made a careful but condensed review of the literature pertaining to the earlier Miocene deposits in California, particularly with reference to the use of the terms *Monterey Series* and *Monterey Formation*. According to Dr. Louderback the usage of writers for one decade was to follow the lead of Dr. A. C. Lawson, who in 1893, proposed the adoption of the name *Monterey* as "the local designation of the series"—represented at Monterey and Carmelo Bay. This "local designation", Louderback interprets to mean, and to include, the whole of the "depositional province", including these localities, and in proof of his contention, quotes the language of a part of Dr. Lawson's text.

Without debating the correctness of this interpretation it may be well to remark incidentally that the extent and limits of this basin or "depositional province" are not defined or even suggested, but presumably it does not extend beyond the boundaries of the California interior valleys. If the same liberty of interpretation be allowed to reviewers of Dr. Louderback's paper that this author assumes in his cursory reviews of others it will be fair to say that his "depositional province" doubtless coincides in extent and boundaries with the Temblor basin described in a former paper by the senior author of this paper.

The papers written during the succeeding decade, 1904 to 1912, show a vigorous and healthy scientific advance, and mark an epoch of progress in geologic study of the California Miocene, and of the Tertiary as a whole. But complaint is made by the reviewer quoted above against the "multiplication of formational names, both within the limits of the ('Monterey') series and throughout the Tertiary terranes", and this increase in formational names is styled "dismemberment", and it is said to be "confusing and rather discouraging to one who wishes to acquaint himself with the real essentials of the geologic history of that time".

In reality this "multiplication" was a direct result of inquiring study into the character and composition of a great succession of unclassified strata, and its complex history and changing faunas, and it clearly marks an advance in our knowledge of both the physical events of the time and of the resulting facts of deposition and organic development. The adding of three or four formational names was only incidental to the study and differentiation of the strata, and it was evolutionary and unavoidable, if any progress was to be made in our acquaintance "with the real essentials of the geologic history of that time". An increase in names could only be discouraging to one who does not desire an acquaintance with the essential facts, or who assumes an acquaintance that he does not possess, or by one who is unaware of the value of intensive study.

Within the limits of California there is much to be done in the way of finding a proper basis of stratigraphic classification of the Miocene, and its faunal changes. The area described in the second part of this paper, like many others that should be better known, has its own contribution to make toward the final result, and will serve to illustrate anew an interesting problem, and to some extent show the complicated nature of the Neocene provinces and their environments, and their phases of deposition. Faunal differences have hitherto been ascribed to progressive time development, and inland districts having faunas somewhat different from those along the present coast have been pointed to in proof of such contention, on the theory of a gradual subsidence and progressive continental transgression. The soundness of this view has still to be proved.

It has yet to be shown that the so-called *Vaqueros* beds of the Salinas valley are older in time than the Temblor deposits at the base of the Miocene within the Great Valley. Little or nothing is gained by assuming as settled facts, views that upon last analysis will be shown to be purely speculative.

During the past several years considerable stratigraphic and areal work has been done in and about the oil and gas districts of central California by the writers of this paper, and by those who have contributed to the information and fossil materials herein represented. This work has extended not only over the proved oil districts of the San Joaquin Valley, or better, the Temblor Basin; but following the lead of prospective evidences of oil it has extended into neighboring territory and into outlying districts which have contained only doubtful evidences of petroleum, or where only stratigraphic resemblance allied them to the oil-bearing formations in other districts. This work has necessarily covered much territory outside of the limits of proved or even prospective petroleum lands. But nevertheless it has thereby led to a broader and better understanding of the stratigraphic conditions of the oil bearing formations, and of other associated strata, above and below.

However, not all of the work upon which this and subsequent papers are to be based was done as economic exploration, for much of it in fact was done for purely scientific purposes, or solely to extend the boundaries of geological and paleontological information farther than it had heretofore been carried, and to solve, or aid in solving some of the problems with which these subjects abound. While the distribution and correlation of the larger divisions of the middle Tertiary of California are well known, there are, nevertheless, points of interest in correlation which have not been finally settled, and any additional knowledge that can be added seems fully worth while. The familiar and much debated question of the relation of the lower Miocene of the interior basins to those of the coastal districts has interested the writers in areas intermediate between the Kern River region, the most easterly occurrence of lower Miocene within the Great Valley of California, and the Salinas Valley where lower horizons are supposed to occur. An area some twenty-five miles long and approximately ten miles wide, stretching from Paso Robles in the Salinas Valley southeast to the western border of the Carrizo Plain, was examined and partly mapped, and studied with a view to throwing light on this problem of correlation. The results of this work, while not yielding all that was desired, seem to warrant a brief description as to stratigraphic relations, together with a faunal correlation as far as can be made.

The geology and faunas of some of the outer coastal districts have been studied by H. W. Fairbanks, J. C. Merriam, Ralph Arnold, and the present writers, while areas within the Great Valley have been similarly studied by several workers, including Ralph Arnold, Robert Anderson, H. R. Johnson, and the writers. Meanwhile, the areas lying along the southern border of the Temblor Basin west of the Great Valley and intermediate in position, have generally escaped the notice that they have deserved. Aside from the brief reference by Antisell in the Pacific Railroad Reports, there are only meager accounts of their geology or paleontology to be found in the literature of California geology.

Among these lower Miocene localities are those in northern San Luis Obispo County, as well as the locality on Los Vaqueros Creek, Monterey County, from which the name "Vaqueros Formation" has been derived. The additions here made to the lower Miocene fauna of California come from a more exhaustive study of these deposits, and of those on the Kern River along the eastern border of the Temblor Basin. In no other part of the province of geology is the value of intensive stratigraphic work and of invertebrate paleontology as an aid, more clearly disclosed than in the systematic study of the marine oil-bearing formations of California. It is not difficult for the paleontologist familiar with these horizons and their faunas, to follow or identify them in districts outside of productive fields, and thereby in some measure judge of the merits of untried areas. Much of the pioneer development work of the oil districts of this state has been guided consciously or otherwise by "fossil shells", even by unscientific operators.

In a systematic study of the various deposits, economic and other, that belong to the Pacific Coast Tertiary, there are not only practical and local problems, but there are problems of provincial, regional, or even continental extent that require consideration, and which can not be overlooked by the philosophic student who would correctly understand his data. For this purpose it would be desirable to know much about the climatic conditions of the Tertiary, and the environment of its local faunas. Too little attention has hitherto been given to these and similar phases of West Coast geology.

However, it is not the purpose to undertake an extensive discussion of stratigraphy, faunas or climate in the present paper, but merely to suggest the subjects, which, it is hoped, will be further treated hereafter and incidentally to introduce into the literature a few of the hitherto undescribed invertebrate species in advance of subsequent discussions.

The new species and subspecies of marine mollusca described in this paper have been obtained from the middle and lower Miocene of central California and other provinces at various times during the last two or three years. Among the contributors of material to this paper have been Mr. R. B. Moran, Mr. W. H. Ochsner, Mr. A. G. Carpenter, Mr. John P. Buwalda, Mr. Charles Morrice, and the writers. The field work and mapping of the San Juan district and the discussion of its geology and other features is the work of the junior author.

NEOCENE RECORD IN THE TEMBLOR BASIN

The Temblor Basin

This basin has already been defined as occupying the larger part of the Central Valley of California and the neighboring intermontane valleys to the west. It is more accurately represented on the map (Plate 9) which shows it bounded on the west and south by the Santa Lucia, San Raphael, the San Emedio and Tehachapi ranges, and on the east by the foot hills of the Sierra Nevada. It is not known to extend farther north than the Marysville Buttes, though Neocene and older Tertiary strata may occur there. An inspection of the map shows the Temblor Basin to be divided by mountain ranges extending through it from southeast to northwest, beginning near the San Emedio Range at the south and extending north to the Straits of Carquinez. These ranges form two groups running nearly parallel, but diverging toward the northwest. Toward the southeast they approach or merge into each other in the region of Coalinga.

The Mount Diablo Range forms the more easterly group and is more continuous and more important than the other, which includes the San Jose, Gavilan, Santa Cruz and other intervening minor ranges.

Several small intermontane valleys are enclosed among these mountains, including the Carrizo, Cholame, Peachtree, San Benito, and Santa Clara valleys, and a few others of smaller size.

Mount Diablo Range.—The Mount Diablo Range embraces a number of minor ranges that are more or less separated and distinct, though having a greater measure of continuity than the more westerly group. Among its units are included the Temblor, Avenal, San Benito, Panoche, Mount Hamilton, and other ranges of less importance. J. D. Whitney divided the Mount Diablo Range into six sections which he believed to be more or less distinct. For the most part these divisions are offset from each other, having a somewhat *en echelon* arrangement, forming spurs that project in turn into the Great Valley. This fact has been mentioned before, and was first described by the senior author in 1903, in a paper read before the Cordilleran Section of the Geological Society of America[1] though it was not mentioned in the published abstract. The causes and significance of this peculiar and interesting condition have never before been explained, and it is one of the aims of this paper to call attention to it as one of the most important facts to be considered in the study of the diastrophic record of the California Neocene.

Neocene Deposits.—While the larger portion of the Neocene deposits of California is included in the Temblor Basin there are important areas in the coastal valleys to the south. It is believed that the most complete, and therefore the most representative, deposits of the California Neocene are to be found within this larger basin. If older Neocene strata exist outside of this area their existence has not been proved, and it appears to be unlikely that any do exist.

The Mount Diablo Range occupying as it does a central position in this basin should furnish the most reliable key to the physical history, stratigraphy, and classification of the deposits, which are here most representative of the Neocene of California. While Neocene deposits are found in all of the intermontane valleys among the interior ranges, their most complete development is found either within the drainage of the Salinas River, or in some respects, better still, on the eastern flanks of the Mount Diablo Range, as will be shown hereafter. The eastern flank of this range occupies the most central position of the basin. Descriptions of some of these Neocene strata have already been published in the several papers devoted to different portions of the range,[2] and in the

[1] Bull. Geol. Soc. Am., Vol. 15, pp. 581 and 582.
[2] Proc. Calif. Acad. Sciences, Vol. II, No. 2;
Proc. Calif. Acad. Sciences, Vol. III, pp. 1-40;
Bull. No. 398, U. S. Geol. Surv., pp. 46-179;
Bull. No. 406, U. S Geol. Surv., pp. 31-107.

second part of this paper devoted to the Geology of the San Juan district.

Structures.—The Neocene structures now found in and about the Temblor Basin, and illustrated by the structures in the Mount Diablo Range, are the final result of far-reaching geo-dynamic activity that has operated through several periods and epochs of geological history. The general aspect of the Geomorphic Map of California and Nevada shows the results of compressional stresses that have acted from east to west in the extensive wrinkling of the surface. This dynamic activity probably began in Mesozoic time or earlier, but it is certain that a large part of the distortion of the later strata was effected in Tertiary or post-Tertiary time. In fact, as will be shown later, much of it must have been accomplished in middle or early Miocene time.

The general effect of this activity or tangential thrust is expressed in the Mount Diablo Range in two important ways, each of which is better exhibited here than in any other part of the basin.

One of these effects is the widespread longitudinal folding of the Tertiary and older strata along the flanks of the various divisions of the range, as is to be seen in the several anticlines and synclines along the eastern flank of the range and in and about the oil districts, and on the San Juan River.

Another effect is the breaking up of the main range into orogenic blocks, as will be shown later, each having a more or less independent diastrophic history. The structures herein described are at one with, and dependent upon, the diastrophic movements of the several blocks or divisions of this range, and this is what should have been expected. An inspection of the structures depicted on the maps of the Coalinga and McKittrick-Sunset districts shows a general system of folding which involves all of the Neocene strata about the several oil districts from Coalinga to Sunset. The principal folds, anticlinal and other, follow a somewhat northwest to southeast course which is in a measure parallel in all of the more northerly districts, but which turns more easterly at the south.

These foldings, as well as their grouping, will be seen to have a definite and consistent relation to the faulting that has taken place chiefly at right angles to the general axis of the

Mount Diablo Range. Some of these faults may be mentioned in this connection, but will be dealt with later. One of these may be called the Antelope Valley fault and is imperfectly described by Arnold and Johnson as traversing the northern border of the Antelope Valley.

Another is the Bitterwater fault which crosses the northern end of the Temblor Range, extending in a northeast to southwest direction.

A third is that described by the same authors as the Temblor fault, cutting obliquely across the range from east to west near the Temblor ranch house. Other minor faults may be noticed from an inspection of the map, but not all of them are well shown in detail on the published maps.

The San Andreas fault, although it traverses the eastern border of the San Juan district, has had little or no effect upon developing any of the structures to be seen therein, or to be seen in any part of the neighboring region. It clearly is of recent origin and its importance belongs almost entirely to the present epoch and to the human settlement of the country. The amount of horizontal displacement along its course is hardly noticeable.

Orogenic Blocks.—The breaking up of the Mount Diablo Range into separate blocks, and the divisions recognized by Whitney, have already been referred to. The following sketch

Figure 1.—Diagram showing the en echelon arrangement of the different parts of the Mount Diablo Range.

to illustrate the general facts was made use of in an earlier discussion[1] of the stratigraphy of the southern Coast Ranges

Bull. No. 406, U. S. Geological Survey, p. 100, et seq.

[1] Unpublished manuscript 1903. See Abstract, Bull. Geol. Soc. Am., Vol. 15, pp. 581-582.

of California. A full discussion of this interesting topic can not be given at the present time, but some suggestions are offered.

As is partly shown on the areal map of the McKittrick-Sunset district, one of the main effects of the disturbances which produced the transverse faulting is seen in the offsetting of the several formational zones cut by them, with a wide lateral displacement of the northern blocks to the eastward with respect to the others. This lateral displacement is best shown in the abrupt termination of the several belts. The offsetting of the Temblor (Vaqueros) beds is not less than that of the Cretaceous, which is not small, amounting to approximately three miles in the case of the Bitterwater fault, and possibly to even more in the case of the Antelope Valley fault. Interesting suggestions are also to be seen in the distribution of the Temblor (Vaqueros) rocks along the line of the Temblor fault and also the minor faults not named. On the other hand the Monterey shales, as mapped on the McKittrick-Sunset sheet, show no appreciable offsetting on some of these faults, while on others they do. In the case of the Temblor fault the Monterey shales are overlapped by later, perhaps Etchegoin beds, and if there is any offsetting it is obscured or hidden. On the Bitterwater fault there is no offsetting of the Monterey, and this is known to be the case on the Antelope Valley fault, or on its projection westward beyond the boundaries of the map.

It would appear from these observations that the faulting and offsetting of the formations took place chiefly during middle or early Miocene time, after the deposition of the Temblor beds and prior to that of the Monterey shales, though some similar movements may have occurred since.

Similar facts of discordance, and other corroborative evidence of this order, are to be observed in other parts of the Temblor basin and in districts outside of it, as will be shown later. The displacement of the Cretaceous and the Temblor on the Antelope fault and other eccentricities and discordances of stratigraphy and sequence emphasize the individuality of these several orogenic blocks. North of the Antelope Valley, the Tejon, upon which the Temblor appears to rest conformably, is well developed. South of the Antelope Valley no Tejon is shown, and the Temblor rests upon Cretaceous or Franciscan rocks. The development of the Temblor group north and south of these fault zones is as uniform in thickness, lithology, and fauna, as could be expected. On the south, between the Temblor and Antelope valleys, the Temblor strata are from 1000 to 1500 feet thick. On the north, as developed about the Sunflower (McClure's) Valley, it may vary from 500 to 1500 feet, as exposed at different points. It is quite possible that the shales overlying the terriginous sandstones in this locality should be included with the Temblor.

As regards the Monterey north and south of these fault zones, there is very great discrepancy in thickness and development. South of the Antelope Valley thick beds of Monterey are indicated on the map, and near Carneros Springs these beds are little less than 3500 feet in thickness. Earlier estimates of these strata included beds that probably are of Santa Margarita age. It is doubtful, on the other hand, if Monterey strata exist at all north of the Antelope Valley, and none is shown on the map of the Coalinga District. It is useless to argue about the difficulty of discriminating here between Temblor and Monterey upon the basis of lithology or any other character. The fact remains indisputable that the Miocene beds north and south of these fault zones are entirely different for all parts of the section above the Temblor. These facts are entirely explainable upon the assumption of distinct orogenic blocks having independent and separate diastrophic movements after the close of the Temblor epoch, but they are not readily explainable upon any other basis.

A study of the Mount Diablo Range as a whole discloses the fact that it consists of a number of orogenic areas that differ in various parts of their Neocene stratigraphy. One of these areas or blocks comprises the Temblor Range adjacent to the San Juan district. A minor block is enclosed between the Antelope Valley and the Bitterwater faults, and is of triangular shape. A larger block embraces that part of the range between the Antelope Valley and the Waltham Creek valley, and still other blocks may be defined north of Coalinga. Many of these blocks, which are in fact separate diastrophic areas, were noted by Professor Whitney in his subdivisions of the Mount Diablo Range. The extent to which this subdivision of the range could be carried is not known, but it is sufficient for the present purpose to point out the fact that there are separate orogenic blocks within the southern portion of the range. Two important results of this breaking up of the range may properly be noticed here, though the full treatment of the subject must be deferred.

The first point of importance is the accord shown between the displacements due to thrust-faulting, and the folding, or wrinkling of the strata. In the case of the Avenal block, lying to the north of the Antelope Valley, the tangential shortening of the section is effected by folding on the eastern side of the range, as is seen in the anticlines and synclines about the Sunflower Valley and the Kettleman Hills. In the case of the Temblor block the shortening has taken place mainly on the Carrizo side of the range, as is to be seen in the anticlinal folding in the San Juan district, though to a less degree on the eastern side in the high inclination of the Miocene strata along the eastern slopes. In what may be known as the McKittrick-Midway block the folding and shortening is again largely on the eastern side of the range, as may be seen about these oil districts in the various anticlines and synclines as already stated.

Had the strata of the San Juan district been sufficiently rigid to have withstood the thrust from the southwest without crumpling, the Temblor Range would have been carried farther eastward, with the development of greater or more numerous folds on the eastern flank.

In accord with this the offsetting of the strata would have been much less along the transverse fault line, bounding this block on the north.

The second point of importance to be noted in connection with the breaking up of the range into orogenic blocks is the separate and independent vertical movements noticeable in the case of each. For just as there have been differential horizontal movements with respect to each other, there have also been vertical movements, showing the general independence of each orogenic block. This is shown in the well known discrepancies in the Neocene stratigraphic sequences of the various blocks, but the subject is too large to receive an extended treatment here.

Disturbances noted elsewhere.—Reviewing briefly some of the corroborative evidences of wide-spread disturbances in early Miocene time attention may be called to the following: 1904, H. L. Haehl and Ralph Arnold showed that eruptions of diabase and basalt took place during the early Miocene. We read: "The diabase breaks through beds of lower, and perhaps middle, Miocene age; while the associated diabase tuff is interbedded with strata containing a typical lower Miocene fauna and lies below the Monterey shale. The basalt outflow exposed near Stanford University overlies and metamorphoses beds of lower Miocene age, and is overlain by beds containing a fauna very similar to the underlying strata. This evidence indicates the lower Miocene age of the basalt and its probable contemporaneousness with the diabase of Mindego and Langley Hills".[1]

These facts are in accord with the unconformity shown in the discordance of dips between "Monterey strata and those of the Vaqueros sandstone" described in the same district.[2]

Attention may be called here to the intrusion of diabase into the Temblor beds of the San Juan district.

In the vicinity of Edna, and south of San Luis Obispo, Temblor beds are found overlaid with thick strata of rhyolite tuff, and this in turn is covered by a greater thickness of Monterey shales. With the exception of the Temblor (Vaqueros) beds these facts are well represented on the geologic sheet of the San Luis Folio. However, the Temblor beds are well exposed with many characteristic fossils directly south of San Luis Obispo and east of the creek of the same name. On the geologic sheets these Temblor beds are represented as Monterey. However, as they contain *Turritella inezana* Conrad, *Pecten magnolia* Conrad, *Conus hayesi* Arnold and *Dosinia whitneyi* Gabb, the lower Miocene (Temblor) age need not be questioned. It is not unlikely that these rhyolite beds are genetically connected with eruptions of considerable magnitude that have occurred about San Luis Obispo. These beds of tuff extend in a south-easterly direction toward Santa Maria and beyond, and are covered by beds of siliceous shales, as they are near San Luis Obispo.

[1] Proc. Am. Philos. Soc., Vol. 43, p. 18.
[2] Santa Cruz Folio, descrip. text, p. 4.

Quite similar beds of ash or tuff, though not so thick, occur in the lower Miocene beds of Point Sal, as described by Dr. Fairbanks.[1] It is quite likely that the ash beds at Point Sal are a part of the same general outburst that spread the ash and tuff over the San Luis quadrangle not far distant. There are many geological facts in all parts of the Coast of a similar nature. The tufaceous beds in the lower Miocene of Kern River need only be mentioned in this connection.

A time correlation of all these facts of disturbance, eruptions and stratigraphic discordances, etc., is obviously suggested by the facts themselves, and it is most likely that the same geodynamic action was the prime cause of them all, which thus found various expression in different districts.

Neocene Record.—With the exception of the diastrophic events related in the preceding pages as intervening between the Temblor and Monterey epochs, and their respective stratigraphic groups, the major Neocene disturbances are fairly well illustrated in diagramatic form in a former paper.[2] The portion of the curve representing the Temblor-Monterey subsidence should show interruption and unconformity, to some extent at least, and in this respect it will conform more closely to the sequence of events suggested by Dr. J. P. Smith in a tabular statement giving the Neocene Sections of California.[3]

This classification recognizes the main historical facts that have been demonstrated in the Neocene record of California. The order of events may be summarized as follows:

1. A subsidence, possibly gradual, that led the sea into the Temblor Basin, with the development of an important series of deposits known as the Temblor group, containing a well developed subtropical fauna.

2. An interval of disturbance, uplift and displacement that interrupted the continuity of sedimentation in many parts of the coast. These disturbances were accompanied by considerable volcanic activity that spread both basic and acid lavas and tuffs over land and sea, as is especially shown about the southern borders of the basin and in the neighboring districts

[1] Bull. Geol. Dept. Univ. Calif., Vol. II, p. 16.
[2] Proc. Cal. Acad. Sci., Vol. III, p. op. 118.
[3] Jour. Geol., Vol. 18, p. op. 226.

December 30, 1914.

to the south. Possibly these coastal eruptions can be identified with some of the earlier Neocene volcanics of the Sierra Nevada, and the Great Basin region.

3. A slow and prolonged subsidence that effected the development of a great accumulation of strata known as the Monterey group, or "Monterey formation". In most parts of the Coast this group consists largely of organic siliceous deposits of diatomaceous shales, though containing other materials as well. It is not coextensive with the Temblor group in area, either within the Temblor Basin or outside of it. Its fauna is scant and of boreal aspect, and it marks a distinct change in the physical geography of the time.

4. Uplift and folding and an interval of denudation and erosion, that must have been far reaching as shown by its effects upon faunal development in the epoch following.

5. Subsidence that again extended the sea in the Temblor Basin with the development of thick deposits of largely terriginous sediments, not coextensive in area with the preceding Monterey group, and resting unconformably upon it. This subsidence was not so profound as that of the Temblor or Monterey epochs and led to the reintroduction into the basin of subtropical species, as is shown in the faunas of the Santa Margarita (San Pablo) deposits throughout the central California coast.

6. Uplift and local denudation, that again interrupted the continuity of sedimentation in many parts of the basin and probably in other regions, and that was of sufficient extent in time or place to again effect important faunal developments, as shown in the succeeding group.

7. Subsidence that once more rearranged the distribution of land and sea about the Temblor basin, with the development of a new group of sediments known as the Etchegoin group, not coextensive in area with the preceding Santa Margarita (San Pablo) group, and not containing the same number

or percentage of subtropical species. This epoch of subsidence did not terminate entirely until the final uplift that closed the occupation of the basin to marine conditions.

8. Uplift that expelled the sea from almost the entire basin, and left it under oscillating conditions only in the deeper portions of the same. This interval of uplift and oscillation developed the subgroup of upper Etchegoin strata which contains an alternating series of marine and freshwater sediments and faunas in the deeper portions of the Great Valley.

9. Differential local uplifts that expelled the sea entirely from the basin but impounded and retained an extensive body of freshwater within the Great Valley, in which were subsequently developed the series of sediments known as the Tulare group. The Tulare should probably be correlated in time with the marine Merced group which is well developed about the seaward outlets of the Temblor basin and in other similar situations along the coast.

10. The general, or continental, uplift that brought the final close of the Neocene and initiated the Pleistocene and its widespread terrestrial conditions.

Conclusions.—It is a well-known fact that the development of the Neocene in central California, where its largest area exists, is very great, at several places being not less than 6000 feet in thickness. It is evident that this basin should therefore be regarded as containing the most representative section of these rocks in California.

For purposes of intensive study this enormous aggregate of strata should be divided into as many groups and divisions as the geological facts in the case will sustain. The facts of prime importance bearing upon this problem are those connected with the physical and dynamic history of the period. The first object to attain in its solution is the clear understanding of its diastrophic record.

That there is considerable complexity in the diastrophic record of the Neocene in its most representative areas is evident to any one familiar with the literature and with the facts throughout the field. In the Mount Diablo Range there are three diastrophic events, perhaps of epochal duration, marked by wide stratigraphic displacement, crumpling of strata, discordance and unconformity. The earlier of these events took place in early Miocene time, and was accompanied by much volcanic activity. As an event in the physical history of the Miocene it serves as a proper basis for the separation of two stratigraphic groups of Miocene strata. The older group, from its occurrence along the eastern flank of the Temblor Range, has been described as the Temblor group, and it is representative of the lower Miocene throughout the Temblor Basin, and probably throughout the entire state.

The second group of strata is that which is locally well developed in the Temblor Basin, and which may be referred to as the "Monterey formation", as entirely distinct from the Temblor group. This separation is not made upon the basis of lithology, though incidentally for most parts of the basin the group, or "formation" is characterized by siliceous organic shales of a peculiar nature.

The second diastrophic event is that which resulted in the great discordance and widespread unconformity within the Temblor Basin between the Monterey group and the next succeeding group, which is here called the Santa Margarita. This event is not known to have been accompanied by volcanic outbursts of great importance, but was chiefly characterized by uplift, erosion and subsidence, and by differential warping of the land surface.

A third diastrophic event divides the record of the later Miocene, and is recorded in the unconformity of the Etchegoin group upon the Santa Margarita, and the wide overlap of the former upon rocks much older than the Miocene.

Other uplifts of lesser rank have affected the Neocene series in various parts of the Coast, and of this basin, but their full treatment is beyond the limits of this paper.

The latest Neocene group is partly of freshwater character and partly marine. It is the Merced-Tulare that may in part, or as a whole, be regarded as later than the Orinda formation of the Berkeley Hills.

Lithologically, there is considerable difference in the composition of the several groups of Neocene strata herein described, but while some of these differences are more or less constant they can not serve as a basis of a division into formational groups, except locally, and with some reserve.

The areal mapping of the various groups of the Neocene is attended with the same sort of difficulties as the stratigraphic determination, and for the same reasons.

Paleontology is a useful aid in making, or rather in identifying, the divisions, but the final word has not yet been said as to the range of species; in fact, there are still many undescribed species to be found in different portions of the series. Among the important facts to be considered in connection with the faunas as reflecting the changes in physical geography is the alternation of sub-tropical and boreal faunas, in the principal divisions of the series, the Diatomaceæ being of boreal aspect.

THE SAN JUAN DISTRICT

General Statement

Location.—The territory comprised in this district includes a relatively small area in the north-central part of San Luis Obispo County extending from the Carrizo plain northwestward to the Salinas Valley, thus covering the northwestern end of the Carrizo Valley and the northern flank of the San Jose Range, west to Creston and beyond. This district includes, therefore, the southern border of what is sometimes known as the Estrella Valley, and is included within the drainage of the San Juan and the Estrella, a main tributary of the Salinas River. The area lies intermediate between that of the San Luis Folio mapped by H. W. Fairbanks, and that of the McKittrick-Sunset District mapped by Arnold and Johnson. The areal geology is therefore in a measure tied to each of these areas. In a topographic and in a structural sense it lies between two of the more important ranges of this region, namely the San Jose and the Temblor ranges. The former borders it on the southwest as a massive abutment, and the latter, as the southern unit of the Mount Diablo Range, separating it from the Great Valley. It may be considered as belonging to the southeastern end of the Salinas branch of the Temblor Basin, with which it was almost solely connected in later Tertiary time. (See map, Plate 10).

The San Jose Range is the dominating feature of the district on the south. It rises to a maximum elevation above 4000 feet. The numerous spurs and ridges descending from it have no definite orientation, but strike obliquely or at right angles from the main divide, which trends in a northwest and southeast direction.

While the general area of the San Juan district is but little less than 2000 feet above sea level it has relatively low relief when compared with the more rugged topography of the neighboring range. The hills are well rounded and the slopes gentle. The low ridges and spurs have a general northwest and southeast direction, conforming to the larger topographic features. Recent stream erosion has cut deeply into the softer Tertiary formations, and all of the streams, and even the larger gulches and ravines, have fairly well-developed flood plains within the area of these formations. Within the area of older rocks the ravines and gulches are steeper and narrower, and with hardly any flood plains developed.

Geology

Basement Rocks.—The basement on which the Neocene and later sediments rest in the area covered by the mapping is almost entirely of granite. There are a few scattered patches of limestone in this area but they are mostly small and relatively unimportant. They are probably remnants of some paleozoic formation into which the granite has been intruded. A larger body of such limestone lies outside of the area covered by actual mapping, toward the north. It makes up a large part of the floor of Cholame Valley to the north and east of Shandon.

The boundaries of the basement rocks have not been mapped in detail. They compose the general areas of the Coast Ranges which represent the insular land masses of the early Neocene in the Temblor Basin. The San Jose Range lying immediately to the south of the San Juan district is composed almost entirely of granite. Along the eastern flank of the granite on the upper tributaries of the San Juan there are some sandstones and shales that are probably Cretaceous, and both Cretaceous and Eocene rocks are found in the Temblor Range and are indicated on the areal map of the McKittrick-Sunset district.

Neocene Rocks.—The oldest sedimentary rocks with which we are directly concerned are of lower Miocene age and belong to the Temblor group. The Temblor sediments range in character from conglomerates and coarse granitic sandstone at the base to finer sandstone, sandy clays, and argillaceous shale at the top. The coarseness and composition of the rocks and their hardness vary considerably, and there are few sections that are alike in sequence and character, although coarse materials predominate at the bottom and finer materials at the top, as a rule, and in this respect there is some uniformity.

The rocks of the Temblor group occupy a long narrow strip of varying width extending from the Salinas Valley, near Atascadero, southeast to San Juan River and beyond. In a few localities stream gravels and alluvium have completely covered these beds so that they can not be traced continuously across the district. One notable occurrence of this alluvium may be seen between Cammattii Canyon and Navajoa Creek in the northern part of T. 29 S., R. 16 E. The general strike of the beds is N. 60° to 70° W. in the western part of the area and about N. 40° to 50° W. in the eastern part of the district near La Panza. They dip away from the granite toward the northeast at angles which rarely exceed 30°.

The lowest beds of the group rest directly upon the eroded surface of the granite, there being no intervening marine sediments such as are found elsewhere in the Coast Ranges of California. Between the marine sandstone and the unaltered granite there is a zone of weathered granite consisting of numerous large boulders and angular fragments which do not show the rounded surfaces so characteristic of water worn materials. The degree of weathering shows every gradation from slightly weathered granite to coarse arkose sandstone, so that in some localities it is difficult to draw a sharp line of demarkation. In the N. W. ¼ of Section 26, and the N. E. ¼ of Section 27, T. 28 S., R. 14 E., there are several good exposures of this zone of weathered granite. These exposures occur in the canyon walls and the creek banks near the county road. Above this zone of weathered granite there are several hundred feet of coarse granitic sandstone. The degree of compactness varies considerably, many well-cemented layers being interstratified with softer materials. Overlying the coarse sandstone are several hundred feet of softer, medium grained sandstone. Near the middle of the section there is 100 feet or more of coarse granitic, well cemented sandstone containing a few fossils, among which *Scutella norrisi* Pack, is the most characteristic. Above this coarse fossiliferous sandstone there are several hundred feet of medium to fine grained sandstone and sandy clays. Near the top of the section, immediately beneath the overlying shales, the beds are essentially soft sandy clays with a few thin seams of tawny colored limestones. This section may be considered representative of the Temblor in the western part of its area.

East of the San Juan River in the N. E. ¼ of T. 30 S., R. 17 E., a different sequence of sediments is exposed. Here a rugged and conspicuous mountain mass lies between San Juan River and the western border of the Carrizo plain. When seen from a distance this prominent ridge appears much like the granitic hills west of the San Juan River, and might easily be mistaken for such. On closer observation, however, it is found to consist of massive thick-bedded gray sandstone, usually coarse grained and conglomeratic, but having interspersed through it thin beds or layers of clay shale. This massive sandstone, when compared with the beds a few miles to the northwest, could easily be mistaken for this older formation. The finding of well preserved Temblor fossils near the base, however, has shown it to be only a special development of the Temblor beds. Near the top of this section the sediments become soft, fine grained, sandy clays, that grade into clay shales of the character common in the Monterey, but as a good fauna of Temblor species is found in the beds overlying it there can be no mistake that it is also to be included in the Temblor.

The Temblor group of this section can be separated into three distinct lithological divisions. The lowest member is that already described. The next division consists of sandy clay shales and fine grained gray or brownish sandstone with which are interstratified numerous thin layers and lenses of limestone, some of them sparingly fossiliferous. The sandy gray shales resemble lithologically some of the strata of the overlying Monterey. The third member of the group is a brownish or gray, arkosic sandstone of medium or coarse texture several hundred feet in thickness. With it are associated several small areas of diabase which occur as intrusions into the sedimentary rocks. Overlying the coarse granitic sandstone are several hundred feet of rather brownish fine sandstone and clay shales. Numerous well preserved fossils have been obtained from this upper member of the Temblor.

The average thickness of the Temblor group in the western part of the area is between 1000 and 1500 feet. In the section just described between the west border of the Carrizo plain and the San Juan River it probably exceeds 2000 feet.

Farther to the southeast the Temblor group attains a still greater thickness, probably exceeding 2500 feet, where it includes one or more beds of white or rusty siliceous shale. This is part of the thick series of Miocene rocks referred to in a former paper by the senior author in which the estimated thickness was greatly exaggerated on account of folding and reduplication.[1]

The section of the Temblor group east of the San Juan River recalls the type section of the Temblor which is less than 20 miles to the northeast, on the eastern slope of the Temblor Range near the Carneras Springs. As stated in the original description, the middle member of the Temblor beds consists of about 600 feet of "siliceous and clay shales with interstratified sandstone".

These Temblor beds are mapped on the geological sheet of the McKittrick-Sunset district as two narrow parallel zones of "Vaqueros" strata separated by a thick bed of "Monterey Shale."[2] Similar occurrences of the Temblor group have been noted in other districts, and in fact are not rare. The association of diabase with the Temblor as intrusions near the top of the group will be referred to again. These rocks are shown on the extreme western border of the McKittrick-Sunset map, though in not very accurate detail.

The small area of strata indicated doubtfully as Oligocene on the same map is probably the shale member of the Temblor and lies stratigraphically between two well developed zones of the same, in both of which are many undoubted species of Temblor fossils. From the uppermost member of the Temblor group at this point were obtained the following species:—

[1] Bull. Geol. Soc. Am., Vol. 15, pp. 581-582.
[2] Bull. No. 406, U. S. Geol. Surv., pp. 47-50.

Cardium vaquerosense Arnold.
Chione temblorensis Anderson.
Phacoides richthofeni Gabb.
Pecten andersoni Arnold.
Venus pertenuis Gabb.
Conus hayesi Arnold.
Conus owenianus Anderson.
Nassa arnoldi Anderson.
Neverita inezana Conrad.
Oliva californica Anderson.
Pleurotoma dumblei Anderson.
Trochita, sp.
Trophon gabbianum Anderson.
Turritella ocoyana Conrad.

Faunal Relations of Temblor.—A large number of well preserved marine invertebrates was obtained from nearly all horizons in the Temblor of the San Juan area. The greater portion of them, however, came from strata near the middle of the section where the character of the sediments is most favorable for the preservation of organic remains. In comparing this fauna with that obtained from the lower Miocene of other localities, such as the Kern River district, Kern County, and Los Vaqueros Valley, Monterey County, it will be seen that nearly all the Temblor species found in the San Juan district occur in the Temblor group of Kern River, while some of the species most characteristic of the lowest horizon, in Los Vaqueros Valley have not been found in the San Juan district. There is some evidence, however, that the Temblor of the San Juan district is not far removed, stratigraphically, from the lower horizon of the Los Vaqueros Valley, which has been referred to as the Turritella inezana Zone. In the Los Vaqueros Valley, *Scutella norrisi* Pack occurs with *Pecten sespeensis* Arnold, *Thais vaquerosensis* (Arnold), *Turritella inezana* Conrad, and a number of other species which are common in both horizons of the lower Miocene of Kern River and the San Juan district. In the San Juan district, *Scutella norrisi* Pack and *Astrodapsis merriami* Anderson occur together in a coarse sandstone near the middle of the series in Sec. 30, T. 28 S., R. 15 E., East of the San Juan River along the north edge of Sec. 3, T. 30 S., R. 17 E., *Scutella norrisi* Pack occurs in a massive, coarse sandstone a short distance below a very fossiliferous horizon which contains a large number of species that are common in the Temblor of the Kern River district. *Scutella norrisi* Pack has been considered to be characteristic of a lower horizon of the lower Miocene in the valley districts, and the finding of this species associated with *Astrodapsis merriami* Anderson, in rocks only a short distance below beds containing the typical Temblor fauna, makes it appear that the Turritella inezana Zone and the Turritella ocoyana Zone were not widely separated in time.

The following is a list of species that have been obtained from the lower Miocene beds of Kern River, the San Juan area, and Los Vaqueros Valley.

	Los Vaqueros Valley	San Juan	Kern River
Echinodermata.			
Astrodapsis merriami Anderson	×	×	
Scutella norrisi Pack	×	×	
Pelecypoda.			
Arca osmonti Dall		×	×
Cardium quadrigenarium Conrad	×	×	
Cardium vaquerosense Arnold		×	
Cardium, sp.	×		
Chione conradiana Anderson		×	
Chione latilaminosa, new species			×
Chione mathewsonii Gabb	×	×	×
Chione panzana, new species		×	
Chione temblorensis Anderson		×	×
Corbicula dumblei Anderson			×
Cytherea diabloensis Anderson		×	×
Diplodonta buwaldana, new species			×
Diplodonta parilis Conrad	×		
Donax (?) triangulata, new species			×
Dosinia mathewsonii Gabb	×	×	×
Dosinia ponderosa Gray		?	×
Glycymeris branneri Arnold			×
Glycymeris, sp.			×
Leda ochsneri, new species			×
Macoma calcarea Gmelin			×
Macoma nasuta Conrad	×	×	×
Macoma ocoyana Conrad	×		×
Macoma piercei Arnold			×

	Los Vaqueros Valley	San Juan	Kern River
Pelecypoda.			
Mactra albaria Conrad			
Mactra catilliformis Conrad		×	×
Mactra sectoris, new species			×
Metis alta Conrad		×	×
Mytilus mathewsonii Gabb	×	×	×
Mytilus, sp.		×	×
Ostrea eldridgei Arnold	×		
Panopea estrellana Conrad		×	×
Pecten andersoni Arnold		×	×
Pecten branneri Arnold			×
Pecten magnolia Conrad	×		
Pecten nevadanus Conrad	×	×	?
Pecten peckhami Gabb			×
Pecten perrini Arnold			×
Pecten sespeënsis Arnold	×		×
Pecten vanvlecki Arnold		×	?
Pecten vaughani Arnold		×	
Phacoides acutilineatus Conrad	×	×	×
Phacoides richthofeni Gabb	×	×	×
Phacoides sanctaecrucis Arnold	×	×	×
Poromya gabbiana, new species		×	
Saxidomus nuttalli Conrad		×	×
Semele morani, new species		×	
Tellina nevadaënsis, new species		×	×
Tellina tenuistriata Davis		×	×
Tellina wilsoni, new species		×	
Transennella joaquinensis, new species			×
Venus pertenuis Gabb	×	×	×
Yoldia temblorensis, new species			×
Gastropoda.			
Agasoma barkerianum Cooper		×	×
Agasoma sanctacruzanum Arnold		×	×
Agasoma sinuatum Gabb	?		
Amphissa posunculensis, new species			×
Astyris pedroana Conrad		×	×
Bathytoma keepi Arnold		×	×
Bathytoma piercei Arnold		×	×
Cancellaria condoni Anderson		×	×
Cancellaria dalliana Anderson		×	×
Cancellaria joaquinensis Anderson		×	×
Cancellaria nevadaënsis, new species		×	×

	Los Vaqueros Valley	San Juan	Kern River
Gastropoda.			
Cancellaria pacifica Anderson		×	×
Cancellaria posunculensis, new species		×	×
Cancellaria sanjoseënsis, new species		×	×
Cancellaria simplex Anderson		×	×
Cerithium arnoldi, new species			×
Chrysodomus kernensis, new species			×
Conus hayesi Arnold		×	
Conus owenianus Anderson		×	×
Crepidula praerupta Conrad		×	×
Crepidula princeps Conrad		×	×
Cuma biplicata Gabb	?		
Dentalium petricolum Dall			×
Drillia antiselli, new species		×	
Drillia buwaldana, new species			×
Drillia howei, new species			×
Drillia kernensis, new species			×
Drillia ochsneri, new species			×
Drillia ocoyana, new species			×
Drillia temblorensis, new species			×
Drillia wilsoni, new species		×	
Epitonium posoënsis, new species			×
Epitonium williamsoni, new species			×
Eulimella californica, new species			×
Eulimella gabbiana, new species	?		
Eulimella ochsneri, new species			×
Ficus kernianus (Cooper)		×	×
Fossarus dalli, new species			×
Lacuna carpenteri, new species			×
Melongena sanjuanensis, new species		×	
Nassa arnoldi Anderson		×	×
Nassa antiselli, new species		×	×
Nassa blakei, new species			×
Nassa ocoyana, new species		×	×
Natica inezana Conrad (?)		×	×
Neverita callosa Gabb		×	×
Niso antiselli, new species		×	
Oliva californica Anderson		×	×
Oliva futheyana Anderson		×	×
Olivella pedroana Conrad		×	×
Pyramidella cooperi, new species			×
Scaphander jugularis Conrad		×	×
Sigaretus scopulosus Conrad	×	×	×
Siphonalia posoënsis, new species		×	

	Los Vaqueros Valley	San Juan	Kern River
Gastropoda.			
Thais vaquerosensis (Arnold)	×		
Terebra cooperi Anderson		×	×
Trochita costellata Conrad	×	×	×
Trophon gabbianum Anderson		×	×
Trophon kernensis Anderson		×	×
Turritella inezana Conrad	×		
Turritella ocoyana Conrad		×	×
Turritella variata Conrad		×	

Monterey Shale.—As in many other localities in the Coast Ranges of California, the Temblor group is overlaid along the San Juan River by a series of light colored organic shales with apparent, though probably not actual, conformity. The stratigraphic position and lithologic character of these beds make them conspicuous, and their strong lithologic contrast with the terriginous beds which they overlie makes the mapping of their contact comparatively simple. As there is no evidence, faunal or other, that they form a part of the underlying group, they have been referred to as the Monterey division of the Neocene. Their composition varies considerably within this district, though the predominating type of rock appears to be a mixture of siliceous, organic and bituminous shale, with terriginous clay shale and fine sand. The purely diatomaceous shale is much less prominent than in other areas where the Monterey group abounds. In the lower part of the group there is a large percentage of clay shale interstratified with siliceous, bituminous layers, while higher up organic materials are not prominent. In the northern part of Sec. 28, T. 28 S., R. 14 E., the lower part of the group consists to a large extent of light pumiceous rocks which are probably in part of volcanic origin. With this exception the Monterey rocks are largely a mixture of fine sandy clay and siliceous organic materials. The rocks of this type outcrop almost entirely across the San Juan district, in a zone parallel with the Temblor strata. To some extent and in some places they are covered by deposits of later age.

The Monterey group, as in all other localities where it occurs, is conspicuously unfossiliferous, except for the microscopic organisms which are of little value for correlation. The average thickness of the beds is between 600 and 1000 feet.

The Santa Margarita Group.—Overlying the Monterey group is a thick aggregate of strata consisting of gravelly sands, conglomerates, granitic sandstones and sandy clays that form a distinct group, lithologically. It is here classed as the Santa Margarita group, though perhaps the equivalent of the San Pablo of the Mount Diablo region. Although this group of strata appears to have a much greater thickness and to contain older beds than the Santa Margarita formation does in its type locality, for reasons which will be given later, it has been included entirely under this name. The Santa Margarita group, as well shown toward the southern part of the district, is unconformable upon the older groups, and although in some localities its relations are obscure, the evidence of unconformity is satisfactory in others.

The Santa Margarita group is the most prominent in the San Juan district on account of its thickness and great areal distribution. In the western part of the district it occurs as a long narrow zone parallel and adjacent to that of the Monterey shale. In the eastern part of the area the Santa Margarita outcrops in a rectangular zone which parallels and flanks San Juan River. If the covering of stream gravels and alluvium were removed from the surface, the Santa Margarita would be found to occupy nearly half of the San Juan district on the north and east.

At the base of the series there is a thin zone of soft, sandy clay shales which grade downward into the Monterey and upward into medium grained sandstone which is followed above by coarse arkosic sandstone and gravelly sands. The latter predominate throughout the formation, although there are numerous layers of soft sandy clays interstratified with the coarser sediments. East of the San Juan River, in the central part of T. 29 S., R. 17 E., the formation is composed almost entirely of coarse granitic material which is often so well cemented by the lime from fossil invertebrates that it stands out prominently on the hillsides in rugged outcrops.

A careful measurement of the thickness of these beds is difficult on account of numerous folds in the formation. The minimum thickness is estimated at 1500 feet and in many places it cannot be less than 2500 feet.

The correlation of these beds with the Santa Margarita formation need not depend alone upon the invertebrate fossils found in them. The character of the sediments and their stratigraphic position is almost as convincing as their fauna. A careful working out of the faunal zones in the Santa Margarita formation would doubtless enable us to correlate them with great accuracy as to detail. However, as this has not been possible in the present work the writers are not able to give an exact paleontological correlation of their various members. There is some stratigraphic evidence, however, that is worth consideration. The Santa Margarita in its type locality lies unconformably upon the Monterey group. This unconformity is marked by the presence of numerous angular fragments of Monterey shale in the basal beds and also, in some localities by a discordance in the attitude of the strata. In some parts of the San Juan district the Santa Margarita is apparently conformable upon the underlying Monterey, and the separation between the two is made largely upon the lithologic characters. In the Mount Diablo region the relations of the San Pablo formation to the underlying Contra Costa County Miocene, the middle and upper parts of which are probably the equivalent of the Monterey, while in some places obscure, and in general apparently conformable, there are nevertheless a few localities where there is evidence of unconformity. Further south in the Mount Diablo Range there is quite definite evidence in certain districts of unconformity between the Santa Margarita and Monterey Shale. On the eastward slopes of the Santa Lucia Range, west of the Salinas Valley, the Santa Margarita is certainly unconformable upon the Monterey in numerous localities.

It thus appears that during the deposition of the Santa Margarita vertical movements took place along the Santa Lucia Range, and probably likewise in the Mount Diablo Range, allowing a portion of the basin of deposition to be raised above sea level while the area now occupied by the San Juan district remained undisturbed and received continuous deposits. These uplifts taking place at the close of Monterey time and continuing during the early part of Santa Margarita (San Pablo) time, followed by subsidence, resulted in the absence of the lower beds in the areas that were elevated. In the San Juan district where deposition was continuous the whole series is present, while along the eastern slope of the Santa Lucia Range only the middle and upper portion is represented. The character of the sediments and the comparatively small thickness of the beds at Santa Margarita agree in support of this explanation. In the region of Mount Diablo and Pinole, if the San Pablo is conformable upon the underlying beds, as it appears to be, we have the same condition that is here described, and the Santa Margarita of the San Juan district could be the equivalent of the San Pablo. The following species were obtained from the Santa Margarita of the San Juan district, and warrant the approximate correlation of these beds with both:—

Astrodapsis antiselli Conrad
Astrodapsis tumidus Remond
Astrodapsis whitneyi Remond
Chione, sp., *a*
Chione, sp., *b*
Macoma nasuta Conrad
Ostrea panzana Conrad
Ostrea titan Conrad
Phacoides, sp.
Pecten crassicardo Conrad
Pecten estrellanus Conrad
Pecten sancti-ludovici, n. sp.
Trophon carisaënsis Anderson
Turritella carrisaënsis, n. sp.
Tamiosoma gregaria Conrad

Etchegoin Group.—The occurrence of the Etchegoin group within the limits of the San Juan district has not been recognized, neither has it been disproved. A few miles to the east of the San Juan ranch house there are thick beds of clays, sands and gravels dipping to the westward that may in part belong to this group. In their physical appearance they are not unlike beds of Etchegoin age in the region of the Kettleman Hills. These beds of possible Etchegoin age are

December 30, 1914.

covered by well stratified beds of the following group in which freshwater shells have been found plentifully in certain localities.

Paso Robles Formation.—The Santa Margarita is overlaid unconformably by a series of gravelly sands and sandy clays that are, in part, at least a portion of the formation which is prominently developed in the Salinas Valley, and which has there been called by the name, Paso Robles formation, and has been supposed to be of freshwater origin.

The limits and distribution of this formation along the San Juan River are rather obscure, and it is difficult to separate it from the stream gravels and alluvium which is believed to be largely of Quaternary age. In the canyons east of the San Juan River, and dipping at a considerable angle westerly are sandstones and gravels with interstratified beds of clay which rest upon strata of possible Etchegoin age. These overlying strata contain numerous shells of freshwater mollusks. Among the species collected from these beds are

Lymnæa cubensis Lea,
Lymnæa, cf. obrussa Say,
Physa heterostropha Hald?, and
Planorbis, sp.

Along the northern and eastern parts of the district the Miocene is extensively covered by the Paso Robles formation which appears to have once extended entirely across the range in the vicinity of Polonia Pass, and to have been connected with similar beds in the Great Valley.

In former papers these Paso Robles beds have been correlated[1] with the Tulare group which is known to extend into the Antelope Valley on the west side of the Temblor Range.

Stream Gravels.—Overlying all of the older formations and groups from the basement rocks to the Paso Robles there are beds of stream gravels and alluvium widely spread over the entire district. These gravels mantle large areas of the Miocene in the central and eastern half of the San Juan district. They consist of pebbles of quartzite, sandstone, limestone, granite and basalt. They cover the Miocene rocks in all the higher portions of the eastern part of the district to a depth of from one foot to 200 or 300 feet. In general, the Miocene

[1] Proc. Calif. Acad. Sci., Vol. III, page 32.

rocks are exposed only where stream erosion has removed the mantle of gravels. These deposits were eroded from the higher portions of the San Jose Range by the agency of streams and laid down again upon the surface of the Miocene.

An unusual development of these gravels can be seen in the north-central part of T. 29 S., R. 16 E., and in the southern part of T. 28 S., R. 16 E., between Navajoa Creek and Cammattii Canyon. In viewing this region from a distance it appears as a nearly level tableland standing out in sharp contrast to the adjacent hills. Closer observation discloses numerous wide ravines cutting deeply into the apparently flat surface. The areas between these ravines are flat, producing the tableland appearance. The rock exposed in the beds of the ravines is gravel, indicating that the Miocene beds have been covered by them to the depth of the ravines themselves, which in some cases is more than 250 feet. In no locality between the Navajoa Creek and Cammattii Canyon do the Miocene beds outcrop. In the hills east of Navajoa Creek and also west of Cammattii Canyon, rocks of the Miocene group are exposed at elevations far above the beds of the ravines described above. The explanation of this peculiar condition is that the Navajoa Creek has in former time swung back and forth between Cammattii Canyon and its present position, removing all of the Miocene rocks to the depth at least of the present beds of the ravines. This removal of the Miocene rocks from the area probably took place during an epoch of uplift. When the region subsequently sank the flood plain of the Navajoa was aggraded and filled by stream gravels or alluvium at least to its present thickness. Whether these gravels represent remnants of the Paso Robles formation, or not, is a debatable question. In many localities they are associated with sands and clays which are also a part of the Paso Robles formation. In the southern part of the district there is a large area of gravels which is apparently due entirely to stream action. The gravels are distributed over the Miocene sediments almost as far back as the edge of the granite area of the San Jose Range. Along the northern and eastern parts of the San Juan district the Miocene is entirely covered by these gravels, which are in part Paso Robles.

Structure.—The structural features of the San Juan district are best explained and understood with respect to the topography, geology, and dynamic history of the surrounding ranges and of the region.

The district lying, as has been explained, between the San Jose Range on the southwest and the Temblor Range on the northeast, occupies a zone of low foot hills of younger strata intervening and bordering upon both. The dynamic agency that has effected the uplift of these ranges in earlier epochs has been regional and compressive, acting from southwest to northeast, in a direction at right angles to their trend. If at one effort or epoch it has elevated the main ranges, or initiated the main folds of the region, at later epochs it has developed the minor folds in the younger and more yielding strata lying between.

The final result of the thrust movement as expressed in the Tertiary strata along the San Juan River and throughout the district is the development of a number of local and discontinuous anticlines and synclines within the general area of the trough, which therefore might be called a synclinorium.

Along the southwest border of the sedimentary area the strata lie upon the granitic basement dipping away at angles between 10° and 30° toward the northeast.

In the Santa Margarita formation which is the only one exposed over a large part of the district, three or four sharp anticlinal folds have been formed having northwest and southeast axes, that continue longitudinally for limited distances and then plunge or disappear into local synclines with which they are in alignment. The dip on either side of the folds is often so steep as to approach the vertical, and the transverse shortening of the section from northeast to southwest must have been considerable. This area of intense folding extends for only a limited distance to the northwest toward the Salinas Valley, while to the southeast it may be followed toward the closely folded area of the Cuyama River and beyond.

Of the anticlines developed in this area the most conspicuous and persistent is that lying along the western border of the Carrizo Plains, extending from the north side of T. 30 S., R. 18 E., toward the northwest for 15 or more miles, disappearing in the northern part of T. 27 S., R. 16 E. This fold involves all three members of the Miocene series. It is flanked on the southwest by some smaller folds of much less extent. Faulting has taken place along and parallel to several of the folds, but it is not prominent and needs no special consideration here.

The regional disturbances which have originated the foldings along the San Juan River have developed at the same time similar structures in many other districts within and probably without the Temblor basin, as described in the first part of this paper.

Economic Geology

The San Juan district is very largely devoted to stock raising and farming, and there are so far no industries based upon any mineral deposits. There are, however, some deposits of greater or less prospective merits and that may properly be described here.

Oil and Gas.—The San Juan district has been shown to contain a good development of the formations which are oil-bearing in other parts of the state and within the San Joaquin Valley, and to contain also some favorable structures, such as would appear attractive if located within the border of this valley.

Moreover, there are evidences of the escape of gases in the past from the formations exposed at different points along the San Juan River, and some slight signs of oil have been detected in wells sunk into the bituminous shales to the west of the river. These and other "indications" have induced some prospecting to be done for oil, and many have regarded its discovery in commercial quantities as a possibility, and this will not be denied.

However, the major folds in which oil could be stored have been dissected in such a manner by stream action, that if oil were present in large quantities it would be expected to make itself evident in oil saturations of the surface rocks, or in accumulations of asphaltum at the surface. No oil has yet been proved by actual drilling and wide areas on the flanks of the anticlines from which large deposits could be derived are not present. In other words the country available as a primary source of oil is quite restricted, and from this point of view, at least, commercial deposits do not appear likely.

Gold.—The only mineral of economic consequence that has been found in this district is gold. The stream gravels occurring along the canyons, especially on the Navajoa creek near the granite area, and along the small canyon one mile west of La Panza Post Office have been found to be gold bearing. During the period from 1880 to 1886 considerable interest was felt in these localities on account of the discovery of gold, and some placer mining was done along the stream beds but no large mines were developed. As a matter of history this district was known to contain gold before it was discovered by Marshall in 1848 at Coloma.

It is stated that over $1,000,000.00 in gold has been taken from these placers.[1] The De La Guerra gulch was the principal source of the gold.

Other Metals.—There are deposits and veins of other metals, as hematite and chromic iron, known in certain parts of the district, though they are perhaps not important.

On Section 25, Township 30 South, Range 17 East, there is an outcrop of iron gossan that can be followed for a distance of 1000 feet or more along the east side of the San Juan River. It appears to have a thickness of five to eight feet and to cut through an exposure of aplitic rock from north to south, with a steep westerly dip. It is not unlikely that this vein of gossan may mark the surface outcrop of a metalliferous vein other than iron. Exploration might reveal the presence of copper sulphides.

DESCRIPTIONS OF SPECIES.

ECHINODERMATA.

Genus ASTRODAPSIS Conrad

Astrodapsis peltoides, new species

Plate 2, figure 2

All of the specimens of this species are of moderate size, suboval or elliptical, moderately elevated, as in *Astrodapsis whitneyi* Remond; ambulacral areas bordered by shallow but distinct grooves, forming narrow ambulacral ridges and dis-

[1] 8th Rept. State Min. 1888, p. 530.

sected triangular interspaces; ambulacral ridges with slight grooved trough and distinct notch on the periphery.

Dimensions:—Length of the type specimen, 65 mm.; width, 55 mm.; altitude, 17 mm.

Occurrence:—This species occurs at various horizons in the Santa Margarita Formation of the Coalinga district, south of Waltham Creek. It is, however, most abundant in the Trophon zone, a little above the base of the Santa Margarita. This species does not appear to be related very closely to *A. whitneyi* Remond.

Type:—No. 102, Cal. Acad. Sci., Trophon zone, East of Jacalitos Creek, Coalinga, Fresno County, Cal., Lower Santa Margarita Beds. Collector, F. M. Anderson.

PELECYPODA

Genus LEDA Schumacher

Leda ochsneri, new species

Plate 3, figures 8a, 8b and 8c

Shell small, slightly arcuate anteriorly, excavated behind the beaks, rostrate and acute with valves closed at the posterior extremity; basal margin strongly and regularly arcuate, or sometimes slightly truncated at the rear; surface marked with strong concentric lines, polished; posterior ends bearing a shallow oblique groove extending downward from the beaks.

This shell resembles *Leda taphria* Dall, of which it may be the precursor, but it is relatively thicker, less elevated, and less clearly truncated behind.

Dimensions:—Length, 16 to 20 mm.; altitude, 9 to 10 mm.; thickness, 8 mm.

Occurrence:—Lower Miocene of Kern River, Kern County, California, at locality 68.

Type:—No. 103, and cotypes Nos. 104 and 105, Cal. Acad. Sci., on north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house, Kern River, Kern County, California. Coll., J. P. Buwalda.

Named in honor of Mr. W. H. Ochsner.

Genus YOLDIA Möller

Yoldia temblorensis, new species

Plate 3, figure 3

Shell small, oblong ovate, thin, arcuate on lower margin, nearly straight above; beaks central, inconspicuous; hinge margin bent only six degrees from a straight line; anterior end well rounded; posterior end rostrate, almost pointed, slightly open, angulated by an impressed line extending from the beaks downward to the posterior end below the siphonal opening; anterior end similarly crossed by an impressed zone extending from the beaks obliquely downward and forward; surface sculptured by regular lines of growth.

Dimensions:—Length, 18 mm.; width, 7.5 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 68.

Type:—No. 106, Cal. Acad. Sci., on north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house, Kern County, California. Coll., J. P. Buwalda.

Yoldia newcombi, new species

Plate 3, figure 2

Shell small, thin, compressed, ovally elongated; valves equal, very inequilateral, greatly attenuated behind; beaks small, slightly raised, near the anterior extremity; escutcheon lanceolate, very long, bordered by a narrow groove; lunule indistinct; anterior dorsal margin short, nearly straight; anterior end well rounded; base ovately rounded; posterior extremity tapering to a narrow, rounded end, gaping; posterior dorsal margin broadly concave, with the opposed margins projecting above the escutcheon; posterior dorsal area flattened; umbones inconspicuous; interior inaccessible.

Dimensions:—Length, 14 mm.; length of rostrum, 10.5 mm.; altitude, 5 mm.; thickness of both valves, 2.2 mm.

Occurrence:—Lower Miocene of Clallam County, Washington, locality 213.

This species can be easily recognized by its small size and long rostrum.

Type:—No. 237, Cal. Acad. Sci., in sea-cliff ½ mile west of Twin Post Office, Clallam County, Washington. Coll., Bruce Martin.

Named in honor of Dr. C. F. Newcombe.

Genus PECTEN Müller

Pecten sancti-ludovici, new species

Plate 3, figures 10a and 10b

Shell of moderate size, equivalve, inequilateral, strongly ribbed, moderately inflated; umbones narrow and acute; each valve with nineteen or twenty ribs, rounded on the back and separated by narrow V-shaped interspaces; ribs ornamented by about six riblets forming fasciculi more or less beaded or roughened, not spiny; ears unequal, the anterior being nearly twice the length of the posterior, and on the right valve coarsely ribbed; posterior ear smaller and ornamented with wavy radial threads.

Dimensions:—Altitude of the type specimen, 40 mm.; width, 37 mm.; thickness, both valves, 19 mm.

This species differs from *Pecten hastatus* Sowerby, by having uniform riblets.

Type:—No. 107, and cotype No. 108, Cal. Acad. Sci., from the Santa Margarita formation along the west side of the San Juan River about one half mile above the mouth of Navajoa Creek, northeastern San Luis Obispo County, California. Coll., Bruce Martin.

Pecten etchegoini Anderson

Pecten etchegoini Anderson, Proc. Calif. Acad. Sciences, vol, 2, p. 198, pl. 18, figures 92-93, 1905.

Pecten (Chlamys) wattsi var. *morani* Arnold, U. S. G. S. Professional Paper No. 47, pp. 121-122, pl. 10, figs. 3, 4, 5, and 6, 1906.

Pecten (Chlamys) wattsi Arnold, var. *etchegoini* Anderson, U. S. G. S. Bull. 396, p. 77, 1909.

As the above named antedates the species and variety names proposed by Arnold, by at least a year, by the rules of precedence it should stand, and if there are varietal forms that merit distinct names these forms should be regarded as subspecies of *Pecten etchegoini* Anderson.

Genus POROMYA Forbes

Poromya gabbiana, new species

Plate 3, figures 7a and 7b

Shell of medium size, thin, convex, elongate, subquadrate, equivalve, inequilateral; beaks turned inward; umbones inconspicuous, a little anterior to the center; extremities well rounded; anterior dorsal margin slightly convex; posterior dorsal margin concave; base straight, parallel to the dorsal margin, contracted in the middle; surface sculptured with numerous fine concentric lines and small, almost invisible, radial striations, these crossed diagonally by low distant ridges that originate on the posterior dorsal margin, making a sharp convex bend toward the beaks, and then curving gradually downward toward the anterior ventral margin and disappearing on the dorsal area; there are fifteen of these ridges on the type specimen, and nearly twice that number on some of the cotypes; one cardinal tooth in each valve, the cardinal in the left valve diagonally elongate; ligament external; muscular impressions inaccessible.

Dimensions:—Length of the type, 46 mm.; altitude, 22.5 mm.; diameter of single valve, 8 mm.

Occurrence:—Lower Miocene of San Luis Obispo County, California, locality 126.

The living members of this genus are subtropical in habitat. None has been reported from the Miocene of California previous to this account.

Type:—No. 109, and cotype No. 110, Cal. Acad. Sci., in bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E., San Luis Obispo County, California. Coll., Bruce Martin.

Named in honor of Wm. Gabb.

Genus DIPLODONTA Bronn

Diplodonta buwaldana, new species

Plate 3, figures 1a and 1b

Shell small, thick, subcircular in outline, inflated; valves equal, inequilateral, slightly elevated in front of the beaks; beaks prominent, elevated, turned forward, slightly anterior to the center; umbones full and broad; lunule indistinct; hinge line broadly arched; dorsal margins nearly straight in some specimens, slightly rounded in others; extremities well rounded, the posterior usually more broadly rounded than the anterior; basal margin circular; surface polished, marked by numerous fine concentric lines of growth; two teeth in each valve, the right posterior tooth faintly bifid; muscular impressions inaccessible.

Dimensions:—Length of one of the larger specimens, 21 mm.; altitude, 19 mm.; thickness of single valve, 7 mm.

Occurrence:—Not uncommon in the middle portion of the lower Miocene of Kern River, California, locality 65.

This species differs from *Diplodonta parilis* Conrad and *D. harfordi* Anderson by its inflated valves, much more prominent umbones, and more elevated beaks.

Type:—No. 111, and cotype No. 112, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California. Coll., Bruce Martin.

Named in honor of Mr. J. P. Buwalda.

Genus CARDIUM Linn.

Cardium weaveri, new species

Plate 1, figures 3a and 3b

Shell of medium size, rounded at the base, somewhat trigonal, inflated; umbones prominent, curved inward and forward; anterior dorsal slope short and slightly concave with a cordate area immediately in front of the beaks; posterior dorsal slope long and slightly convex making a rather sharp curve into the arcuate base; a conspicuous ridge from the beaks to the posterior ventral extremity, giving the valves an angulated appearance and forming a prominent posterior dorsal area in each valve; sculpture consisting of numerous equally spaced radial striations which are replaced on the posterior dorsal area by flattened radial ribs separated by narrow interspaces, the radial ribs becoming obsolete near the margin; about twenty radial ribs on the posterior dorsal area, and between fifty-five and sixty fine radial striations on the remainder of the surface; hinge, typical of the genus *Cardium*.

Dimensions:—Length of the type specimen, 50 mm.; altitude, 48 mm.; thickness, 38 mm.

Occurrence:—Lower Miocene, or possibly Oligocene, of northwestern Oregon and western Washington. The type was obtained from the bluffs at the west end of the railroad tunnel about three miles southeast of Timber, Oregon.

This species can be easily distinguished by its peculiar radial sculpture. A number of species of *Cardium* from the west coast of North America have less prominent sculpture on the posterior dorsal area than on the remainder of the surface. In this species the reverse is true.

Type:—No. 113, and cotype No. 114, Cal. Acad. Sci., from bluffs at the west end of the railroad tunnel about three miles southeast of Timber, Oregon. Coll., Bruce Martin.

Named in honor of Professor Charles E. Weaver, University of Washington.

Genus CHIONE

Chione panzana, new species

Plate 1, figures 1a and 1b

Shell large, heavy, subtriangular in outline; valves equal, inequilateral, convex, inflated; beaks elevated, turned inward and forward, about one-third the length of the shell from the anterior extremity; umbones full; lunule large, cordate, depressed, sculptured by numerous fine concentric lines, bordered by a narrow groove; escutcheon lanceolate, extending almost to the posterior extremity, crossed by the concentric sculpture; posterior dorsal slope arcuate; anterior dorsal margin strongly excavated in front of the beaks; extremities rather sharply rounded; base arcuate, crenulated within; surface marked by numerous strong, concentric ridges, somewhat irregularly spaced, and many small radiating ribs which are a little less conspicuous than the concentric ridges; hinge plate heavy, with three cardinal teeth, the middle one bifid.

Dimensions:—Length, 78 mm.; altitude, 69 mm.; thickness of single valve, 22 mm.

Occurrence:—Lower Miocene of northeastern San Luis Obispo County, California, the type from locality 53.

This species is related to *Chione securis* Shumard, but differs from it in having fainter crenulations, finer radial lines, curved dorsal border, and narrower escutcheon. It is also much less subtriangular in outline than the latter species. It differs from *Chione temblorensis* Anderson, in not having the angulated posterior ridge nor the prominent concentric ridges.

Type:—No. 115, and cotype No. 116, Cal. Acad. Sci., San Luis Obispo County, California, in a small creek about ¾ of a mile southwest of Lewis House, near the center of the S. E. ¼ of Sec. 22, T. 29 S., R. 16 E., Mt. D. B. L. and M. Coll., Bruce Martin.

Chione margaritana, new species

Plate 2, figure 1

Shell large, subelliptical, very inequilateral; valves equal, convex, inflated; beaks near the anterior margin, not elevated, turned forward; umbones full, narrow; lunule very large, sunken, concentrically striated, bordered by narrow groove; escutcheon broad and long, concentrically striated; posterior dorsal margin long, slightly arcuate; anterior margin strongly excavated in front of the beaks, rather sharply rounded near the base; basal margin broadly arcuate, crenulated within; posterior extremity evenly rounded; surface sculptured with numerous coarse, nearly equally spaced, radiating ribs and fine concentric striations which are irregularly raised, forming concentric ruffles; the radiating ribs absent on the posterior dorsal area; interior inaccessible.

Dimensions:—Length of the figured specimen, 108 mm.; altitude, 83 mm.; thickness of the right valve, 38 mm.

Type:—No. 117, Cal. Acad. Sci., from the top of the Santa Margarita beds in the N. E. ¼ of sec. 25, T. 21 S., R. 14 E. Uncommon in the Santa Margarita beds of the Coalinga region.

Chione (Lirophora) latilaminosa, new species

Plate 1, figures 2a, 2b and 2c

Shell small, trigonal, convex, depressed, very strongly characterized by prominent lamellæ; valves equal, inequilateral; beaks prominent, turned forward, near the anterior margin of the shell; basal margin semicircular, crenulated within; cardinal margins nearly straight, meeting in almost a right angle; lunule distinct, bordered by an impressed line and marked with fine concentric striations; escutcheon large, lanceolate, sloping inward, the lamellæ stopping abruptly at its outer margin; surface ornamented with five or six very prominent reflexed concentric lamellæ, numerous fine concentric lines of growth, and fine radial striations which are hardly visible on some specimens; the concentric lamellæ are wavy and thin on the margins but thick at the base; hinge line angulated, with three cardinal teeth in each valve, the middle one usually bifid.

Dimensions:—Length of the type specimen, 15 mm.; altitude, 8 mm.; thickness of a single valve, 4.5 mm.

Occurrence:—Not uncommon in the middle portion of the lower Miocene of Kern River, California, locality 65.

Type:—No. 118, and cotypes Nos. 119 and 120, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California. Coll., Bruce Martin.

Genus TRANSENNELLA Dall

Transennella joaquinensis, new species

Plate 3, figures 6a, 6b and 6c

Shell small, solid, circular in outline; valves equal, inequilateral, convex; beaks elevated, turned forward a little anterior to the middle; umbones full; dorsal margin concave in front of the beaks, nearly straight behind; extremities well rounded; base arcuate; surface marked with numerous fine concentric lines; lunule cordate, bordered by an impressed line; hinge plate of the left valve with three cardinal teeth and one anterior lateral which is elongated diagonally; the middle cardinal not distinctly bifid; pallial sinus small and shallow.

Dimensions:—Length of the type specimen, 8 mm.; altitude, 7.5 mm.; thickness of the right valve, 2.5 mm.

Occurrence:—Not uncommon in the lower Miocene of Kern River, California, locality 65.

This species can be separated from *Transennella tantilla* Gould and *T. californica* Arnold, by its less elongated form, more elevated beaks, and more prominent umbones.

Type:—No. 120, and cotypes Nos 121 and 122, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California. Coll., Bruce Martin.

Genus TELLINA Linn

Tellina nevadensis, new species

Plate 2, figures 3a, 3b and 3c

Shell large for the genus, compressed, inequilateral, inequivalve; beaks prominent; anterior end evenly rounded; ventral margin broadly arcuate; posterior end rostrate and bent to the right, obliquely truncated; posterior dorsal margin straight from the beaks to the truncation; a prominent fold and a concave flexure extending from the umbones to the posterior ventral extremity and bordering the posterior dorsal area in either valve; right valve convex; left valve nearly flat; surface marked with concentric ridges corresponding to the lines of growth and fine radial lines which are invisible on worn specimens; hinge plate narrow, with two cardinal and two lateral teeth in the right valve, and two cardinal teeth in the left valve; the posterior cardinal in the right valve bifid; muscular impressions large and distinct; pallial sinus very deep, extending almost to the anterior adductor; a thickened obscure ray extending diagonally across the anterior portion of the shell behind the anterior adductor.

Dimensions:—Length of the type specimen, 54 mm.; altitude, 34 mm.; diameter of the right valve, 7 mm. The type consists of one perfect right valve which is accompanied by the left valve of a cotype. Length of the largest specimen, 75 mm.; altitude, 45 mm.; diameter, both valves, 11 mm.

Occurrence:—The type specimen was obtained from the lower Miocene of Kern River, California, locality 65. Other specimens were obtained from the same horizon in the northeastern part of San Luis Obispo County, locality 126.

This species resembles *Macoma nasuta* Conrad and *Macoma piercei* Arnold in general outline. It may be distinguished from these species by the lateral teeth in the right valve, the radial sculpture, and the prominent concave flexure on the posterior portion.

Type:—No. 124, and cotypes Nos. 125 and 126, Cal. Acad. Sci., in bed of small creek, near the center of Sec. 34, T. 28 S., R. 15 E., San Luis Obispo County, California. Coll., Bruce Martin.

Tellina wilsoni, new species

Plate 3, figures 11a and 11b.

Shell small, eight to ten millimeters in length, convex, moderately inflated; valves unequal, inequilateral; beaks conspicuous, within the posterior third; anterior dorsal margin long and straight, nearly parallel to the base; anterior extremity well-rounded; basal margin very slightly arcuate; posterior dorsal margin truncated, sloping sharply downward to the posterior extremity which is sharply rounded into the base; posterior end compressed, flexuous, curved to the right; surface marked by very fine concentric lines of growth which are usually invisible to the unaided eye.

Dimensions:—Length of the type specimen, 9 mm.; altitude, 6 mm.; thickness of the right valve, 2 mm.; thickness of both valves, 4½ mm.

Occurrence:—Not uncommon in the lower Miocene of San Luis Obispo County and of the Kern River region, California. The type specimen, No. 127, Cal. Acad. Sci., was obtained from locality 126.

Genus SEMELE Schum.

Semele morani, new species

Plate 3, figure 4.

Shell of moderate size, compressed, thin, subelliptical in outline; valves equal, convex, inequilateral, the anterior end slightly longer than the posterior; extremities well-rounded; ventral margin arcuate; beaks prominent, turned forward, excavated in front; anterior dorsal margin broadly convex; posterior dorsal margin nearly straight; lunule long and narrow, sunken, surface marked by numerous concentric lines of growth; a prominent flexure or furrow extending from the beaks to the posterior ventral margin; interior inaccessible.

Dimensions:—Length of the figured specimen, 25 mm.; altitude, 21 mm.; thickness of both valves, 8.5 mm.

Occurrence:—Uncommon in the lower Miocene of northeastern San Luis Obispo County, California, locality 126.

Type:—No. 129, Cal. Acad. Sci., in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E., San Luis Obispo County, California. Coll., Bruce Martin.

Named in honor of Mr. R. B. Moran.

Genus DONAX Linn.

Donax triangulata, new species

Plate 3, figure 9.

Valves small, thin, trigonal, convex; beaks a little anterior to the middle; dorsal margins nearly straight; anterior extremity rounded; basal margin nearly straight; posterior end sharply rounded; an umbonal angulation extending from the beaks to the anterior and posterior extremities, forming areas sculptured with six or seven radial ribs; left valve with one cardinal and two lateral teeth; ends crenulated within; muscular impressions indistinct.

Dimensions:—Altitude of the left valve, 5 mm.; length, 9 mm.; diameter of the left valve, 2 mm.

Occurrence:—Lower Miocene of Kern River, Kern County, California, locality 65.

Type:—No. 130, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California.

Genus MACTRA Linn.

Mactra sectoris, new species

Plate 3, figures 5a, 5b, 5c, 5d, and 5e.

Shell small, trigonal, equivalve, inequilateral, almost a quadrant of a spheno-discoidal solid; valves convex, inflated; beaks prominent, elevated, curved inward and forward; the forward dorsal margin slightly concave; posterior, slightly convex or straight; basal margin circular; ends sharply rounded, the anterior usually more so than the posterior; surface showing only

December 30, 1914.

concentric lines of growth which disappear on the earlier portions of the shell; a prominent ridge or angulation extending from the beaks diagonally to the posterior extremity; hinge typical of this genus; muscular impressions inaccessible.

Dimensions:—Altitude, 9 to 10 mm.; length, 10 to 13 mm.; thickness, 6 to 7 mm.

Occurrence:—Found abundantly in the lower Miocene of Kern River, California, locality 69.

Though much smaller in size, the shells of this species are almost exact prototypes of *Spisula exoleta* Gray as figured and described by Arnold, and as represented by a sample collected at San Diego. More than one hundred specimens of *M. sectoris* were obtained from the locality given above, and they were all nearly equal in size, there being no gradation between them and larger specimens. This fact seems sufficient to warrant its description as a new species.

Type:—No. 131, and cotype No. 132, Cal. Acad. Sci., on the south and west slopes of Pyramid Hills, about 15 miles northeast of Bakersfield.

GASTROPODA

Genus CALLIOSTOMA Swains.

Callistoma pacificum, new species

Plate 8, figures 2a and 2b.

Shell conical, thick, with about five convex whorls; spire moderately high; whorls of the spire ornamented with ten almost equally prominent spiral threads separated by narrower interspaces; two of the spiral threads nearest the posterior margin are centrally grooved; suture distinct, impressed; body-whorl slightly concave near the suture, convex over the central portion, sharply rounded at the base, sculptured the same as the whorls of the spire; the base ornamented with eighteen or twenty very fine spiral lines; aperture subcircular; outer lip smooth; columella thickened and incrusted.

Dimensions:—Altitude of the type specimen, 15 mm.; diameter of the last whorl, 14.5 mm.

Occurrence:—Miocene of the Oregon coast, five miles north of Yaquina Bay, locality 36.

This species is very similar to the recent and fossil species, *Calliostoma costatum* Martyn, but can be distinguished from the latter by the fine spiral sculpture on the base. The base of *C. costatum* is sculptured the same as the whorls of the spire.

Type:—No. 134, and cotype No. 133, Cal. Acad. Sci., one-half mile north of Yaquina Head, Lincoln County, Oregon.

Genus NISO Risso

Niso (?) antiselli, new species

Plate 7, figure 22.

Shell small, smooth, with six whorls; spire conical, upper whorls absent in the type specimen; whorls nearly flat, tapering toward the apex, unsculptured; suture appressed; body-whorl sharply angulated at the periphery; base convex, with a distinct umbilicus; aperture quadrate; outer lip distinctly angulated, angle about 100°; inner lip thin, smooth; umbilical opening large but not extending to the apex of the shell.

Dimensions:—Altitude, apex broken, 7.5 mm.; latitude of the last whorl, 4 mm.

Occurrence:—The type specimen was obtained from the lower Miocene of eastern San Luis Obispo County, California, locality 125.

The living species of this genus are found in tropical and temperate seas. The placing of this species in the genus *Niso* is somewhat doubtful. The umbilical opening does not extend to the apex of the shell; it is, however, much more pronounced than in any of the Eulimidæ or Pyramidellidæ and has therefore been classed as a *Niso*.

Type:—No. 135, Cal. Acad. Sci., on top of a hill in the southwest corner of the S. E. ¼ of Sec. 29, T. 28 S., R. 15 E., San Luis Obispo County, California.

Named in honor of Dr. Thomas Antisell, one of the early geologists of California.

Genus PYRAMIDELLA Lamarck

Pyramidella cooperi, new species

Plate 7, figures 18a and 18b

Shell small, turriculated, solid, with nine or ten whorls, apex acute; spire strongly elevated; whorls flatly convex, narrowly tabulated, sculptured with one prominent narrow groove at the front margin; body-whorl rather well rounded below, with short base; aperture subelliptical; outer lip semicircular, denticulated within; columella with one conspicuous posterior plication and two less prominent anterior plications.

Members of this genus inhabit tropical seas.

Dimensions:—Altitude of the type, 11 mm.; maximum latitude, 4 mm.

Occurrence:—From the lower Miocene of Kern River, California, locality 65.

Type:—No. 136, and cotype No. 137, Cal. Acad. Sci., on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California.

Named in honor of Dr. J. G. Cooper.

Genus EULIMELLA Fischer

Eulimella ochsneri, new species

Plate 7, figures 23a and 23b.

Shell small, elongated, slender, with eight or more whorls; spire high, with acute apex; whorls slightly convex, nearly flat, with narrow tabulation at the suture, ornamented with two or three very faint spiral lines near the base; the faint spiral lines at the base of the whorls are not visible on some specimens; suture distinct, channeled; aperture subquadrate; lips simple and smooth; body-whorl with a small umbilical chink.

Dimensions:—Altitude of the type, apex broken, 8 mm.; diameter of the last whorl, 3 mm.

Occurrence:—Not rare in the lower Miocene of Kern River, Kern County, California, locality 64.

Type:—No. 138, and cotype No. 139, Cal. Acad. Sci., in bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California.

Named in honor of Mr. W. H. Ochsner.

Eulimella dilleri, new species

Plate 7, figure 24.

Shell small, elongated, turriculated, solid, with eight to ten whorls; apex acute; whorls smooth, flatly convex; body-whorl sharply rounded below into a convex base; suture impressed, distinct; aperture subrectangular; inner lip reflexed; columella straight, without plications.

Dimensions:—Altitude of the figured specimen, apex broken, 9.5 mm.; maximum width of the shell, 3.5 mm.

Occurrence:—From the Miocene of the Oregon coast, four miles north of Yaquina Bay, locality 37.

This species differs from *Eulimella ochsneri* in having more convex whorls, an impressed suture instead of the appressed suture of the latter, and in being less convex at the periphery of the body-whorl.

Type:—No. 140, Cal. Acad. Sci., Lincoln County, Oregon, in the sea cliff ¼ mile north of lighthouse at Cape Foulweather.

Named in honor of Mr. J. S. Diller, Geologist, U. S. Geological Survey.

Eulimella californica, new species

Plate 7, figures 19a, 19b, and 19c.

Shell small, turriculated, elongated, smooth, solid, with seven or eight whorls; apex acute; whorls with a slight angulation near the anterior margin, flatly convex above, smooth; body-whorl convex at the base, nearly flat above; base not flattened; suture impressed; aperture elliptical; outer lip arcuate; inner lip concave, slightly incrusted.

Dimensions:—Altitude of the type specimen, 4.5 mm.; maximum latitude, 2 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 64.

This species can be distinguished from *Eulimella ochsneri* and *E. dilleri* by its much smaller size, by the slight angulation on the anterior margin of the whorls, the lack of flattened base, and a more elliptically shaped aperture.

Type:—No. 141, and cotype No. 142, Cal. Acad. Sci., in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California.

Eulimella gabbiana, new species

Plate 7, figure 20.

Shell very small, slender and smooth, polished, with numerous whorls; apex acute (broken in the type specimen), whorls nearly flat, unsculptured; suture appressed, indistinct; base unflattened; aperture ovally elongated; outer lip sharply rounded anteriorly; inner lip concave, incrusted.

Dimensions:—Altitude of the figured specimen, upper whorls lost, 4 mm.; maximum width, 1.3 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 64.

This species is distinguished by its small size, slender and smooth form, and its long narrow aperture.

Type:—No. 143, Cal. Acad. Sci., in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California.

Named in honor of Wm. Gabb.

Genus EPITONIUM Bolten

Epitonium posoënsis, new species

Plate 7, figure 10.

Shell conical, solid, with seven or eight whorls; spire elevated; whorls tabulated, nearly flat above, sculptured with twelve strongly raised varices, which are reflexed and broadened on top, and four or five spiral lines which are plainly visible between the varices; varices with prominent shoulders, giving the whorls a tabulated appearance; body-whorl squarely angulated at the base with a keel on the angle; base flat and smooth; aperture circular; outer lip thickened by the varix; inner lip incrusted, smooth.

Dimensions:—Altitude of the figured specimen, apex broken, 14 mm.; diameter of the last whorl, 8 mm.

Type:—No. 144, Cal. Acad. Sci., the lower Miocene of Kern River, California, locality 65.

Epitonium williamsoni, new species

Plate 7, figures 9a and 9b.

Shell long and narrow, with about ten whorls; spire very high; apex sharp; whorls convex, crossed by eighteen prominent, rounded axial ribs extending from suture to suture; interspaces about equal in width to the ribs; the spiral sculpture consisting of small threads, about ten or twelve to each whorl, less prominent than the axial ribs; suture distinct, deeply channeled; two broad continuous varices diagonally crossing each whorl; body-whorl angulated at the base, the angulation carrying a carina; the base sculptured with spiral threads; aperture circular; outer lip thickened; inner lip incrusted, smooth.

Dimensions:—Altitude of the type specimen, apex defective, 18 mm.; maximum diameter of the body-whorl, 6.5 mm.

Occurrence:—From the lower Miocene of Kern River and eastern San Luis Obispo County, California.

This species is named in remembrance of Lieutenant R. S. Williamson who conducted the first exploring expedition to the rich district of Kern River and Poso Creek.

Type:—No. 145, and cotype No. 146, Cal. Acad. Sci., Kern County, California, on west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Genus LACUNA Turton

Lacuna carpenteri, new species

Plate 7, figure 21.

Shell small, thin, conical, with six flat tapering whorls; spire elevated; apex subacute; whorls smooth, flat or very slightly convex; suture distinct appressed; body-whorl large, angulated at the base; aperture ovate; outer lip thin; inner lip smooth, separated from the body-whorl by a small umbilical chink.

Dimensions:—Altitude of the figured specimen, 9 mm.; diameter of the last whorl, 5 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 65.

Type:—No. 147, Cal. Acad. Sci., Kern County, California, on west bank of small canyon 1¼ miles northeast of Barker's ranch house.

Named in honor of Dr. Philip Carpenter.

Genus FOSSARUS Phil.

Fossarus dalli, new species

Plate 7, figures 13a and 13b.

Shell small, subglobose, solid, with three or four whorls which increase rather rapidly in size; spire short; whorls of the spire small, convex, sculptured with spiral threads separated by narrower interspaces, about six on the penultimate whorl; suture appressed; body-whorl more than three-fourths the total length of the shell, convex, globose, sculpture with fifteen spiral threads which are separated by narrower interspaces; aperture elliptical; outer lip arcuate; columellar margin excavated, smooth; a small umbilical chink visible on some specimens.

Dimensions:—Altitude of the type, apex and base broken, 5 mm.; latitude of the body-whorl, 3 mm.

Occurrence:—Lower Miocene of Kern River, locality 64.

The living members of this genus are most commonly found in tropical and temperate seas.

Type:—No. 148, and cotype No. 149, Cal. Acad. Sci., Kern County, California, in bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Named in honor of Dr. W. H. Dall.

Genus TURRITELLA Gray

Turritella carrisaënsis, new species

Plate 4, figure 4.

Shell solid, elongated, turrited, with about ten whorls; spire very high; whorls tabulated at the posterior third; tabulation flat and forming an angle of forty degrees with the axis of the shell; surface in front of the angle flat or slightly concave; ornamentation consisting of four spiral ridges, one prominent forming the angle, two about midway between the anterior margin and the angle, and the fourth, a sutural cord, on the anterior margin; the latter forming a slight angulation on the base of the last whorl; suture deeply impressed; aperture subquadrate.

Dimensions:—Altitude of the figured specimen, apex defective, 76 mm.; latitude of the last whorl, 29 mm.

Occurrence:—Not common in the middle portion of the Santa Margarita (San Pablo) formation in the eastern part of San Luis Obispo County, California, locality 58.

This species can be distinguished by its peculiar tabulation and spiral sculpture.

Type:—No. 150, Cal. Acad. Sci., San Luis Obispo County, California; in the south bank of a small creek in the N. E. ¼ of Sec. 22, T. 29 S., R. 17 E.

Genus CERITHIUM Brug.

Cerithium arnoldi, new species

Plate 7, figure 12.

Shell conical, elongate, small, with nine or ten closely appressed whorls; spire high; apex acute; whorls nearly flat, crossed by numerous irregular wavy, axial ribs which are rendered slightly nodose by the spiral cords; the spiral sculpture on the penultimate whorl consisting of three or four cords separated by wider interspaces which carry small secondary spiral threads; body-whorl carrying seven or eight of the larger spiral cords between each two of which there are three intercalary lines, the middle one slightly larger than the two on either side; base flattened producing a distinct angulation on the anterior portion of the body-whorl; aperture subquadrate; lips simple; canal very short.

Dimensions:—Altitude of the type, 19 mm.; diameter of the last whorl, 7.5 mm.

Occurrence:—A single specimen from the lower Miocene of Kern River, locality 64.

Type:—No. 151, Cal. Acad. Sci., Kern County, California, in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Named for Ralph Arnold in recognition of his valuable contributions to Tertiary paleontology.

Genus ARGOBUCCINUM Morch

Argobuccinum dilleri, new species

Plate 4, figure 7.

Shell large, solid, with nine or ten strongly sculptured whorls; spire high; whorls convex, tabulated, sculptured with eighteen low, rounded axial ribs and numerous spiral cords which alternate in size; the spiral sculpture on the penultimate whorl consisting of four pair of double strap like cords, between each pair of which are three less prominent cords, the middle one being slightly larger than those on either side; the interspaces are narrower than the cords; the double cords produce nodulation on the axial ribs; two rugose discontinuous varices crossing each whorl from suture to suture; entire surface faintly spirally striate; canal and aperture partly defective.

Dimensions:—Altitude of the figured specimens, 65 mm.; maximum diameter of the body-whorl, 44 mm.

Occurrence:—From the Miocene of the Oregon coast, four and one half miles north of Yaquina Bay, locality 35.

This species can be distinguished from *Argobuccinum oregonense* Redfield by a difference in the spiral sculpture and more prominent varices.

Type:—No. 152, Cal. Acad. Sci., Lincoln County, Oregon, along the sea cliff a little south of the mouth of Wade Creek, about six miles north of Yaquina Bay.

Named in honor of Prof. J. S. Diller, Geologist, U. S. Geological Survey.

Genus AMPHISSA

Amphissa posunculensis, new species

Plate 7, figures 11a and 11b.

Shell small, thin, bucciniform, with about seven whorls; spire elevated; apex subacute; whorls well rounded and distinctly cancellated with small rounded axial ribs, separated by much wider interspaces and numerous spiral cords; the axial ribs are slightly nodose where crossed by the spiral cords; there are twenty-four axial ribs and about nine spiral cords of equal prominence on the penultimate whorl; the interspaces between the spiral lines usually carrying small intercalary threads; suture very distinct, channeled; body-whorl large with a broadly angulated base; aperture broadly elliptical; outer lip lirate within; inner lip incrusted; columella short, twisted; canal very short and broad, slightly curved.

Dimensions:—Altitude of the type, apex defective, 18 mm.; diameter of the last whorl, 9 mm.

Occurrence:—From the lower Miocene of Kern River, California, locality 65.

Type:—No. 153, and cotype No. 154, Cal. Acad. Sci., Kern County, California, on the west bank of a small canyon, 1¼ miles northeast of Barker's ranch house.

Genus AGASOMA Gabb

Agasoma columbianum, new species

Plate 5, figures 6a and 6b.

Shell large for the genus, conical above and below, revolute, tuberculated; spire high, having five or six conical whorls, sloping evenly to an acute apex; body-whorl angulated, carrying three rows of laterally elongated tubercules; the upper row most prominent and separated from the next row below by a concave surface; aperture ovate, broad in the middle, narrow before and extended into a moderately long recurved canal; outer lip thin and entire; inner lip incrusted; surface of the shell ornamented chiefly with revolving threads, three of which are prominent, forming the angles and elevated into tubercules; the spiral threads alternating in size and of three or four ranks, crossed at unequal intervals by sinuous lines of growth; suture broadened by thickened and wrinkled collar; canal wide and curved; the aperture is greater in length than the height of the spire.

Dimensions:—Altitude of the type specimen, 56 mm.; maximum width of the shell, 40 mm.; length of the aperture, 35 to 40 mm.

Occurrence:—Pittsburg Bluff, Nehalem River, and near Clatskanie, Oregon. This species is not uncommon in the Oligocene(?) of the Pittsburg horizon. It is not known in the rocks of the Astoria Group or in the older rocks below. It is usually associated with *Macrocallista pittsburgensis* Dall, *Molopophorus gabbi* Dall, and *Nucula shumardi* Dall.

Type:—No. 155, and cotype No. 156, Cal. Acad. Sci., Pittsburg Bluff, Nehalem River, Oregon.

Agasoma acuminatum, new species

Plate 5, figures 4a and 4b

Shell rather large, fusiform; spire elevated though shorter than the mouth, with five or six whorls; whorls angulated a little below the middle, tuberculated on the angles, flattened and sloping regularly above, flattened below; suture distinct and bordered by a wrinkled collar which is ornamented with two or three spiral threads; aperture ovate, elongated into a long recurved canal; canal moderately wide; outer lip thin and simple, not lirate within; inner lip slightly incrusted; surface of the shell ornamented with numerous revolving threads of three alternating sizes, a few of which are coarser than the others, one or two bearing tubercules on the body-whorl.

Dimensions:—Altitude of the type specimen, 60 mm.; maximum latitude of the shell, 30 mm.

Found associated with *Diplodonta parilis* Conrad, *Nucula conradi* Dall, and *Tellina oregonensis* Conrad.

The ornamentation of this species is quite variable as regards the prominence of the tubercules. On some specimens they are pronounced while on others they are almost obsolete.

Type:—No. 157, and cotype No. 158, Cal. Acad. Sci., from the Oligocene(?) or possibly lower Miocene beds about ten miles northwest of Scappoose, Oregon, in Sec. 36, T. 4 N., R. 3 W.

Agasoma oregonense, new species

Plate 4, figures 3a and 3b

Shell of moderate size, fusiform; spire elevated, with seven or eight whorls; whorls angulated near the middle, flat or slightly convex above, cylindrical below, ornamented with numerous spiral threads of alternating magnitude, and irregularly raised axial lines of growth which are most pronounced on the upper whorls where they form nodes on the angulations; suture impressed; body-whorl large, ventricose, slightly constricted in front of the suture, with a rounded shoulder at the posterior third, concave above, convex below, sculptured similar to the whorls of the spire, but lacking the nodes on the shoulder; aperture ovate, outer lip simple, inner lip smooth; canal long and recurved.

Dimensions:—Altitude of the type specimen, 55 mm.; width of the body whorl, 27 mm.

Type:—No. 159, and cotype No. 160, Cal. Acad. Sci., from the Oligocene(?) or possibly lower Miocene, ten miles northwest of Scappoose, Oregon, locality 168.

Agasoma yaquinanum, new species

Plate 4, figures 5a and 5b

Shell pyriform, with five or six tabulated whorls; spire rather low; whorls angulated near the middle, flat above and below giving the shell a beautifully tabulated appearance, sculptured with eleven spiral threads, six above and five below the angle, and a large number of indistinct axial ribs which produce sharp nodulations on the larger spiral threads and especially on the angulations; body-whorl inflated, with a broad tabulation, sculptured with twelve or fourteen major spiral cords between which are three intercalary threads, the middle one of which is slightly larger than those on either side; the interspaces between these secondary spirals again occupied by very fine intercalary lines; axial ribbing almost obsolete on the body-whorl except on the angulation where they form nodes; suture appressed; aperture ovate; lips smooth and simple; canal moderately long and slightly recurved; columella twisted.

Dimensions:—Altitude of the type specimen, 25 mm.; maximum latitude of the shell, 14 mm.

Type:—No. 161, and cotype No. 162, Cal. Acad. Sci., Miocene of the Oregon coast, a little north of the entrance to Yaquina Bay, locality 39.

Genus NASSA Martini

Nassa ocoyana, new species

Plate 7, figure 17.

Shell small, with about five angulated whorls; spire elevated; whorls of the spire nearly flat, tabulated, sculptured with eight or nine broad, rounded axial ribs which are most prominent on the upper portion of the whorl where they produce nodes on the angulation, and seven or eight spiral cords which alternate in size, there being four or five slightly more prominent than those intervening; the axial ribs obsolete on the body-whorl and on the lower portion of the penultimate whorl; suture wavy, distinct, bounded below by a sutural band; body-whorl nearly flat at the center and marked by a strong spiral groove near the base; below the groove are three or four strong spiral threads and about eight indistinct spiral ridges between the groove and the angulation; aperture elliptical, outer lip thickened by a varix; inner lip simple; canal short and recurved.

Dimensions:—Altitude of the figured specimen, canal defective, 11 mm.; diameter of the last whorl, 5 mm.

Occurrence:—Found in the lower Miocene of Kern River and eastern San Luis Obispo County, California.

Type:—No. 163, Cal. Acad. Sci., Kern County, California, in the bottom of a small creek 1¼ miles due north of Barker's ranch house.

Nassa blakei, new species

Plate 7, figures 15a and 15b.

Shell small, ovate, solid, with five or six whorls; spire elevated; whorls of the spire slightly convex, sculptured with four or five spiral lines, and twelve to fifteen raised axial ribs, most prominent at the middle of the whorls; the intersection of the axial ribs and the spiral lines producing small nodes; suture distinct, impressed; body-whorl large, about one half the total length of the shell, with prominent spiral ridges on the anterior and posterior margins, concave centrally, sculptured with numerous spiral lines and axial lines of growth; aperture subquadrate; outer lip thickened, denticulate within; inner lip incrusted, roughened; canal very short and broad.

Dimensions:—Altitude, 9 mm.; maximum width of the shell, 5 mm.; length of the aperture, including the canal, 4 mm.; width of the aperture, 2 mm.

Occurrence:—One specimen, the type, from the lower Miocene of Kern River, California, locality 65.

Type:—No. 164, Cal. Acad. Sci., Kern County, California, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Named in honor of Mr. W. P. Blake.

Nassa antiselli, new species

Plate 7, figure 16.

Shell small, ovate; spire conical, elevated, with five nodose whorls; whorls slightly convex, tabulated, sculptured with three equally spaced spiral cords and about thirteen axial ribs which are equal in prominence to the spiral cords; the intersection of the spiral and axial ribs producing conspicuous nodes; suture distinct, impressed; body-whorl ventricose, sculptured with eight spiral cords and fifteen axial ribs, nodose as the whorls of the spire; aperture elliptical; outer lip thickened by a conspicuous varix; inner lip smooth; columella short, with a small anterior sulcus; canal short and broad.

Dimensions:—Altitude, 8.5 mm.; diameter of the last whorl, 5 mm.

Occurrence:—Lower Miocene of San Luis Obispo County, California, locality 126.

This species can be distinguished by its small size, peculiar nodose sculpture, and prominent varix on the outer lip. It is more elongate and has much coarser sculpture than *Nassa arnoldi* Anderson.

Type:—No. 165, Cal. Acad. Sci., San Luis Obispo County, California, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Named in honor of Dr. Thomas Antisell.

Nassa lincolnensis, new species

Plate 7, figures 14a and 14b.

Shell small, globose, with four or five rather rapidly enlarging whorls; spire of medium height; apex blunt; whorls tabulated, convex, sculptured with three spiral bands between which are equal interspaces, and twelve axial ribs separated by wider interspaces; the intersection of the axial and spiral ribs producing nodes which are most prominent on the angle of the whorls; body-whorl convex, with sixteen axial ribs and eight flat topped spiral bands, the whole surface finely spirally striate; aperture ovate; outer lip simple; inner lip incrusted; columella very short with a distinct anterior sulcus.

Dimensions:—Altitude, 10 mm.; diameter of the last whorl, 6 mm.

Type:—No. 167, and cotype No. 168, Cal. Acad. Sci., Miocene of the Oregon coast, a short distance north of Yaquina Bay, locality 39.

Genus MOLOPOPHORUS Gabb

Molopophorus dalli, new species

Plate 6, figures 7a and 7b.

Shell moderate in size, stout, conical above, not strongly sculptured, with five whorls; spire rather high for the genus, tapering evenly except for the sutural collar; younger whorls ornamented with beaded collars, older whorls with beads obsolete; body-whorl with distinct constriction below collar; mouth ovate, narrowed above; outer lip thin and smooth; inner lip widely calloused; canal very short, wide, recurved; pillar partly encircled by strong plication which forms the outer border of the canal; surface marked by irregular axial ridges crossed by spiral cords.

Dimensions:—Length, 39 mm.; width, 25 mm.

Type:—No. 168, and cotype No. 169, Cal. Acad. Sci., from the Oligocene(?) near Clatskanie, Oregon, locality 165, in a prominent bluff along the county road about 2¼ miles southwest of Clatskanie.

Molopophorus gabbi Dall

Plate 6, figures 5a and 5b.

Molopophorus gabbi Dall, U. S. G. S. Professional Paper No. 59, 1909.

This species has been figured to illustrate the characters which distinguish it from *Molopophorus dalli.* As pointed out by Dr. Dall the form and sculpture of this species vary considerably, and it may be shown later that the form, here described as new, is only a wide variation of *Molopophorus gabbi* Dall. At present there seems to be sufficient difference in form and sculpture to separate the two as distinct species.

Genus CHRYSODOMUS Swains.

Chrysodomus kernensis, new species

Plate 4, figures 6a and 6b.

Shell of moderate size, solid, with seven whorls, nucleus lost on the type; spire high; apex subacute; whorls with well rounded shoulder near the middle, slightly rounded below, flat or concave above, rather strongly constricted in front of the suture forming a distinct sutural collar, sculptured with numerous spiral cords having narrower interspaces; the width of the cords and the interspaces varying considerably, on the anterior portion and just above the shoulder of the body-whorl the cords alternating large and small; in the middle portion nearly equal, with one broad spiral band at the shoulder; the axial sculpture consisting of inconspicuous lines of growth; suture strongly appressed; body-whorl large, about two thirds the total length of the shell; aperture elliptical, outer lip ribbed within, inner lip smooth, calloused; canal short, wide, recurved; columella twisted, with small anterior sulcus.

Dimensions:—Altitude of the type, apex defective, 62 mm.; maximum latitude of the shell, 28 mm.; length of the aperture, including the canal, 31 mm.; width of the aperture, 12 mm.

Occurrence:—Lower Miocene of Kern River and eastern San Luis Obispo County, California. The type was obtained from locality 65.

Type:—No. 172, and cotype No. 173, Cal. Acad. Sci., Kern County, California; on west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Genus SIPHONALIA Adams

Siphonalia posoënsis, new species

Plate 4, figure 2.

Shell large, fusiform, solid, with seven or more whorls; spire high, conical; whorls angulated near the anterior margin, the angulation ornamented with about nine prominent nodes; surface above the angulation nearly flat or concave; sculpture consisting of spiral grooves and axial lines of growth; the spiral grooves somewhat irregularly spaced and the spaces between them often raised forming spiral cords; body-whorl angulated near the middle, concave above, convex below; aperture ovate; outer lip arcuate; inner lip smooth, incrusted; canal moderately long, curved to the left; columella incrusted, with a long anterior sulcus.

Dimensions:—Altitude, 90 mm.; maximum latitude of the last whorl, 45 mm.; length of the aperture, including the canal, 43 mm.; width of the aperture, 17 mm.

December 30, 1914.

Type:—No. 174, Cal. Acad. Sci., lower Miocene of San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Genus MELONGENA Schum.

Melongena californica, new species

Plate 4, figure 1

Shell of moderate size solid, pyriform, with a low spire; whorls of the spire inconspicuous, unsculptured, three or four in number; body-whorl inflated, broadest near the posterior margin, the middle and anterior portion sloping downward to the canal; ornamentation consisting of two rows of nodes; one on the shoulder, and the other a little anterior to the middle, the nodes are pronounced and number about five to a row; aperture oval, inner lip smooth incrusted; columella broad and heavy, with prominent anterior sulcus; canal defective, probably broad and nearly straight.

Dimensions:—Altitude, canal defective, 38 mm.; width of the last whorl, 29 mm.; length of the aperture, including a portion of the canal, about 30 mm.

Type:—No. 175, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 60, on the top of a prominent ridge one mile east of the San Juan River in the N. W. cor. of the N. E. ¼, Sec. 3, T. 30 S., R. 17 E.

This genus has not previously been reported to occur in the Miocene of California.

Genus TROPHON Montf.

Trophon oregonensis, new species

Plate 5, figure 5

Shell large, thick, fusiform, with six or seven angulated whorls; spire elevated; whorls of the spire angulated near the middle, surface flat and smooth above, smooth and sloping inward below; whorls ornamented with nine or ten prominent projecting spines which are excavated in front and convex behind and extending downward to the suture in front forming short varices; suture impressed, wavy; body-whorl ventricose, sharply concave at the anterior margin; aperture ovate; canal moderately long, slightly twisted.

Dimensions:—Altitude of the figured specimen, 58 mm.; maximum diameter of the last whorl, 40 mm.

Type:—No. 176, Cal. Acad. Sci., Miocene of the Oregon coast, four miles north of Yaquina Bay, locality 38.

Trophon kernensis has a lower spire, angulation of the whorls more anterior, and with nodes instead of excavated spines. *Trophon carisaënsis* Anderson, has a smaller number of spines, angulation nearer the anterior margin, and a shorter and much more thickened columella. *Trophon gabbianus* Anderson, is a closely allied species with less prominent spines and ornamented with many revolving cords and grooves on the body-whorl below the shoulder.

Trophon gabbianus Anderson

Plate 5, figure 1.

Trophon gabbiana Anderson, Proc. Calif. Acad. Sci., 3rd Series, Geology, vol. 3, No. 2, page 203, Pl. 16, fig. 79-80.

This species is refigured in order to point out more clearly the distinguishing characters of *Trophon oregonensis,* new species.

Genus THAIS Bolten

Thais trophonoides, new species

Plate 6, figures 1a and 1b.

Shell of moderate size, globose, solid, with five rather rapidly enlarging whorls; spire moderately elevated; apex blunt; whorls of the spire angulated a little below the middle, flat above and below, crossed by nine axial ribs and seven or eight spiral cords; axial ribs most prominent on the angle of the whorl; interspaces between the spiral cords usually occupied by a small intercalary thread; suture appressed; body-whorl large, ventricose, angulated above the middle, marked by nine axial ribs which are obsolete on the anterior portion, and numerous spiral cords between which are intercalary threads; aperture pyriform; outer lip angulated above and below the middle; columella twisted, with narrow groove and a deep anterior sulcus; canal recurved.

Dimensions:—Altitude of the type specimen, 34 mm.; maximum width of the shell, 24 mm.

Type:—No. 178, and cotype No. 179, Cal. Acad. Sci., from the lower Miocene of Kern River, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Thais blakei, new species

Plate 6, figures 4a and 4b.

Shell solid, fusiform, with six whorls; spire moderately high; whorls of the spire with a well rounded angle near the anterior margin, flat or concave above, restricted near the suture, sculptured with spiral cords and coarse, raised, axial lines of growth; seven or eight spiral cords on the penultimate whorl, separated by wider interspaces which occasionally carry a fine intercalary thread; suture appressed; body-whorl with a well rounded shoulder a little in front of the suture, concave above, inflated below, sculptured in the same manner as the whorls of the spire; aperture ovate, outer lip thickened, denticulate within, inner lip smooth, incrusted; canal short, recurved; columella twisted, with anterior sulcus.

Dimensions:—Altitude of the type, apex defective, 34 mm.; maximum latitude of the shell, 17 mm.; length of the aperture, including the canal, 21 mm.; width of the aperture, 6 mm.

Type:—No. 180, and cotype No. 181, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Thais blakei resembles *Thais edmondi* Arnold in general form. It may be distinguished from the latter by its uniformly larger size, longer canal, and the lack of nodes on the shoulder or angle of the whorls.

Thais panzana, new species

Plate 6, figure 6.

Shell solid, of moderate size; whorls five or six; spire elevated, conical; suture distinct, channeled; whorls of the spire conical, slightly concave above the middle, with a row of nodes, around the anterior margin giving them an angular appearance, sculptured with distinct spiral cords separated by narrower interspaces, eleven or twelve on the penultimate whorl; body-whorl large, about two-thirds the total length of the shell, angulated near the middle, concave above, almost flat below and narrowing rapidly to the canal, with eight prominent nodes on the angulation, eight spiral cords above the shoulder and about eighteen below; aperture elliptical, outer lip angulated, inner lip smooth; columella stout, incrusted, with anterior sulcus; canal short, recurved.

Dimensions:—Altitude of the figured specimen, apex defective, 30 mm.; maximum latitude of the shell, 16 mm.; length of the aperture, including the canal, 20 mm.; width of the aperture, 8 mm.

Type:—No. 182, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Thais nehalemensis, new species

Plate 6, figure 3.

Shell solid, fusiform, with about six whorls; spire moderately elevated; apex acute; whorls of the spire concave with a raised anterior margin or collar which is ornamented with twelve to fourteen prominent nodes, the nodes partly obscured by the overlapping of the succeeding whorl; concave area smooth or marked by very fine spiral lines; suture indistinct due to the overlapping of the whorls; body-whorl large, more than three-fourths the total length of the shell, angulated near the middle, concave above, ornamented with thirteen prominent nodes and numerous revolving threads of three or more ranks which alternate regularly; nodes most prominent at the angle, fading out above and on the anterior portion of the whorl; the spiral threads most prominent on the nodose area; aperture oval, outer lip simple, inner lip incrusted, smooth; posterior sinus broad and shallow; canal short and broad, recurved.

Dimensions:—Length of the shell, 33 mm.; maximum diameter of the body-whorl, 19 mm.; length of the aperture and canal, 21 mm.; width of the aperture, 8 mm.

Type:—No. 183, Cal. Acad. Sci., Oligocene or lower Miocene beds ten miles northwest of Scappoose, Columbia County, Oregon.

The presence of the posterior sinus in this species indicates that it might be more properly placed in the *Pleurotomidæ,* but the short and broad canal and general shape of the shell suggest the genus *Thais* to which it has been assigned temporarily.

Genus FUSINUS Rafinesque

Fusinus empireënsis, new species

Plate 5, figure 7.

Shell solid, fusiform, with eight or nine convex whorls; spire elevated; whorls moderately convex, sculptured with seven or eight coarse rounded spiral cords alternating in prominence, the cords on the anterior portion slightly more elevated than those on the posterior, frequently giving the whorls an angulated appearance; body-whorl with eighteen spiral cords, axial sculpture consisting of lines of growth; suture distinct, channeled; aperture rounded or circular; inner lip smooth, lightly incrusted; canal defective in the type, probably of moderate length.

Dimensions:—Altitude, 50 mm.; canal defective; latitude of the last whorl, 23 mm.

Type:—No. 185, Cal. Acad. Sci., from the Empire formation, Miocene of Coos Bay, Oregon, locality 1, in the sandstone exposed on the east shore of Coos Bay, opposite Coos Bay Bar, 100 yards north of the S. W. cor., Sec. 30, T. 25 S., R. 13 W.

Genus CANCELLARIA

Cancellaria lickana, new species

Plate 8, figures 6a, 6b, 6c, and 6d.

Shell globose, solid, with five or six rapidly enlarging whorls; spire low; whorls of the spire small, inconspicuous, convex, sculptured with four or five spiral threads with nearly equal interspaces which carry a fine intercalary thread; suture appressed; body-whorl large, globose, sculptured with about twenty spiral cords and an equal number of intercalary threads; axial sculpture consisting of lines of growth; aperture elliptical; outer lip crenulated; inner lip with heavy callus covering a portion of the body-whorl; canal very short, broad, straight; columella with two plications and an anterior sulcus.

Dimensions:—Altitude of the type, 21.5 mm.; latitude of the last whorl, 16 mm.; length of the aperture, 17 mm.; width of the aperture, 6.5 mm.

Type:—No. 186, and cotypes Nos. 187, 188, 189, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

This species resembles superficially the figures of *Purpura lima* Martyn, published in an earlier paper[1] and referred to by Ralph Arnold in his description of *Cancellaria andersoni*. The species here described differs from *Cancellaria andersoni* Arnold, in not having axial ribbing on any of the whorls, while it shows strong spiral sculpture on all of them. The surface of the body-whorl is not inornate, but is crossed by strong spiral threads and distinct lines of growth which give the surface a doubtfully cancellated appearance.

Cancellaria nevadensis, new species

Plate 8, figures 5a, 5b, 5c, and 5d.

Shell small, solid, ovate, with five or six tabulated whorls; spire moderately high; apex subacute; whorls angulated above the middle, flat or slightly concave above, convex below, sculptured with numerous spiral threads and irregular axial ribs; the interspaces between the spiral threads vary in width and frequently carry intercalary threads; axial ribs most prominent on the whorls of the spire where they form small nodes on the angulations, almost obsolete on the body-whorl of most specimens; suture distinct, impressed; aperture ovate; outer lip thin: canal short and wide; columella with two plications and a small anterior sulcus.

Dimensions:—Altitude of the type, 18 mm.; maximum latitude of the shell, 10 mm.; length of the aperture, 11 mm.; width of the aperture, 4 mm.

Type:—No. 190, and cotypes Nos. 191, 192, 193, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 68, on the north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house.

[1] Proc. Calif. Acad. Sci., 3rd Ser., vol. 2, p. 202, pl. 15.

Cancellaria condoni Anderson

Plate 8, figures 8a, 8b, 8c, and 8d.

Cancellaria condoni Anderson, Proc. Calif. Acad. Sci., 3rd Series, Geol., Vol. 2, p. 200, pl. 15, fig. 49-50, 1905.

This species is refigured here in order to illustrate its variations and to point out more clearly the characters by which it may be distinguished from the new species of *Cancellaria* that are here described.

Cancellaria dalliana Anderson

Plate 8, figures 1a, 1b, 1c, and 1d.

Cancellaria dalliana Anderson, Proc. Calif. Acad. Sci., 3rd Ser., Geol., Vol. 2, p. 199, pl. 15, fig. 39-40, 1905.

Refigured with *Cancellaria condoni* Anderson, see above.

Cancellaria posunculensis, new species

Plate 8, figures 7a, 7b, and 7c.

Shell small, ovate-elongate, with six whorls; spire high; whorls convex, sculptured with about eight spiral threads which are separated by narrower interspaces carrying intercalary lines; axial sculpture consisting of close-set lines of growth, much less pronounced than the spiral threads; the intersection of the axial and the revolving lines producing a delicately cancellated surface; suture distinct, impressed, bordered anteriorly by a small tabulation; body-whorl large, about three-fourths the total length of the shell, gracefully convex, ornamented with eighteen major spiral threads between which are smaller intercalary lines; axial sculpture same as on the whorls of the spire; aperture elliptical; outer lip arcuate, denticulate within; canal short, curved; columella long and recurved, carrying three plications, two of them slightly larger than the third.

Dimensions:—Altitude of the type, 17.5 mm.; maximum diameter of the body-whorl, 8 mm.; length of the aperture, including the canal, 10 mm.

Type:—No. 202, and cotypes Nos. 203 and 204, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon, 1¼ miles northeast of Barker's ranch house.

Cancellaria rotunda, new species

Plate 8, figures 4a and 4b.

Shell globose, thin, with five well rounded whorls; spire rather short; apex blunt; whorls of the spire convex, ornamented with thirteen prominent rounded axial ribs with wider interspaces, and five or six spiral threads with very small intercalary lines; suture depressed; body-whorl comprising the greater portion of the shell, evenly globose, sculptured the same as the whorls of the spire, with thirteen axial ribs and sixteen spiral threads; the axial ribs much more pronounced than the spiral threads; the interspaces between the spiral threads carrying intercalary lines; aperture semicircular; outer lip thickened; inner lip incrusted; canal short; columella with two plications on the anterior portion.

Dimensions:—Altitude of the type, 14 mm.; maximum latitude of the shell, 12 mm.; altitude of an entire specimen, about 21 mm.

Type:—No. 205, and cotype No. 206, Cal. Acad. Sci., Miocene of the Oregon coast, a half mile north of Yaquina Bay, locality 39.

Cancellaria sanjosei, new species

Plate 6, figures 2a and 2b.

Shell small, ovate, thick, with five or six rather rapidly enlarging whorls; spire elevated; whorls slightly convex or flat, with a narrow tabulation, sculptured with seven or eight flat spiral cords, the alternate cords being slightly more prominent than those adjacent; suture distinct; body-whorl large, about five-sixths of the total length of the shell, tabulated above, sculptured with fourteen major spiral cords with alternate small intercalary threads; aperture elongate-oval, outer lip thick, columella with two plications and an anterior sulcus; canal short.

Dimensions:—Altitude of the type specimen, 20 mm.; diameter of the body-whorl, 11.5 mm.

Type:—No. 207, and cotypes No. 208, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Genus ADMETE

Admete clatskaniënsis, new species

Plate 8, figures 3a and 3b.

Shell small, ovate, thin, with six tabulated whorls, nucleus excluded; spire high, with an acute apex; whorls angulated at the middle, flat above, convex below, sculpture consisting of twelve broad, rounded axial ribs which are most prominent on the angle where they are slightly nodose, becoming obscure near the suture and on the anterior portion of the body-whorl, crossed by ten spiral threads on the penultimate whorl, four above the angle and six below, the latter alternating in prominence; suture distinct, channeled; body-whorl convex, with fifteen spiral threads which alternate in size, the interspaces on the anterior portion containing a small intercalary thread: aperture oval; outer lip arcuate; canal short; columella with two small plications and a small anterior sulcus.

Dimensions:—Altitude of the type specimen, 10 mm.; maximum diameter of the last whorl, 5 mm.

Type:—No. 209, and cotype No. 210, Cal. Acad. Sci., Oligocene(?) (or Miocene) of Columbia County, Oregon, two and one-half miles southwest of Clatskanie.

Genus TURRIS Bolten

Turris lincolnensis, new species

Plate 6, figure 8.

Shell large, fusiform, with seven or eight whorls; spire high, with an acute apex; whorls of the spire obtusely angulated a little anterior to the middle, nearly flat above and below, slightly concave near the suture; ornamentation consisting of prominent nodes and fine spiral threads separated by wider interspaces carrying fine intercalary lines, fifteen nodes and about twenty-four major spiral threads on the penultimate whorl; suture distinct, appressed; body-whorl ventricose, ornamented with a row of nodes a little above the middle producing a slight angular appearance, convex above and below, constricted at the suture; spiral sculpture similar to that of the whorls of the spire; aperture oval, with a broad and shallow posterior sinus; canal moderately long.

Dimensions:—Altitude of the figured specimen, apex and canal defective, 43 mm.; width of the last whorl, 24 mm.

Type:—No. 211, Cal. Acad. Sci., Miocene of the Oregon coast, five miles north of Yaquina Bay, locality 36.

This species is near *Turris coli* Dall, which has the nodes extending to the suture above and is not distinctly angulated. The new form has nodes instead of ribs, and is angulated.

Turris carlsoni, new species

Plate 5, figures 2a and 2b.

Shell large and solid, fusiform, with about eight whorls; spire high, with an acute apex; whorls of the spire with a subdued angular appearance below the middle, slightly concave above, convex below, ornamented with a row of nodes on the angulation, and numerous spiral striations somewhat alternating in prominence; suture appressed, bordered by a sutural collar; body-whorl ventricose, convex near the middle of the whorl, with inconspicuous or obsolete nodes, spiral sculpture the same as on the upper whorls; on some specimens the lower portion of the body-whorl is marked by raised spiral cords and intercalary lines in place of the incised lines or striations; aperture oval, with a simple outer lip; columella incrusted, smooth, with an anterior sulcus; canal moderately long, curved to the left.

Dimensions:—Altitude of the type specimen, canal defective, 44 mm.; width of the last whorl, 21 mm.; length of the aperture, including the canal, 25 mm.

Type:—No. 212, and cotype No. 213, Cal. Acad. Sci., Miocene of the Oregon coast, six miles north of Yaquina Bay, locality 36.

Named for John I. Carlson of the California Academy of Sciences.

Genus BATHYTOMA Harris & Burrows

Bathytoma condonana, new species

Plate 7, figure 8.

Shell of moderate size, ovate, with elevated spire and acute apex; whorls six or seven, ornamented with a row of nodes near the anterior margin, concave above, finely cancellated with numerous spiral threads and fine axial ribs; the penultimate whorl carrying twelve nodes on the angulation; suture distinct, strongly appressed; body-whorl large, ventricose, angulated above the middle, concave above, convex below, marked in front of the angle with numerous raised spiral ridges with wider interspaces carrying small intercalary threads.

Dimensions:—Altitude of the figured specimen, 16.5 mm.; diameter of the body-whorl, 9.5 mm.

Type:—No. 214, Cal. Acad. Sci., lower Miocene of the Oregon coast, four miles north of Yaquina Bay, locality 39.

Named in honor of the late Professor Thos. Condon, University of Oregon.

Genus DRILLIA Gray

Drillia ochsneri, new species

Plate 6, figures 9a, 9b, and 9c.

Shell large, fusiform, with high spire and acute apex; whorls eight or nine, angulated a little below the middle, concave above, flat or convex below, crossed by ten or eleven low axial ridges most prominent on the shoulders where they form nodes, but disappearing above the shoulder on the whorls of the spire and on the anterior portion of the body-whorl; spiral sculpture consisting of revolving threads which occur only on the anterior portion of each whorl; nodes obsolete on the body-whorl of some specimens; suture distinct; aperture narrowly elliptical, with a deep posterior sinus between the shoulder and the suture; columella smooth and twisted; canal moderately short and curved.

Dimensions:—Altitude of the type specimen, 43 mm.; diameter of the last whorl, 20 mm.; length of the aperture including the canal, 22 mm.

Type:—No. 215, and cotypes Nos. 216, 217, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

This species has been referred to in a few cases as *Drillia johnsoni* Arnold. It differs from the latter in the following respects: angulation of the whorls more anterior, nodes and axial ribbing more pronounced and of a different character, and the shell broader in proportion to the altitude.

Named in honor of Mr. W. H. Ochsner.

Drillia wilsoni, new species

Plate 6, figures 10a, 10b, and 10c.

Shell large for the genus, elongated, solid, with eight or nine whorls; spire elevated; whorls sharply angulated at the middle, very concave above, flat or slightly convex above, crossed by ten rounded, oblique axial ridges rising to prominent nodes on the angles, becoming fainter or disappearing immediately above; the axial ridges crossed by spiral cords separated by grooved interspaces in front of the shoulder on each whorl, four or five on the penultimate whorl, and eighteen or twenty on the last whorl; aperture ovate; columella smooth, straight; canal moderately long, nearly straight.

Dimensions:—Altitude of the type, with defective apex, 47 mm.; diameter of the last whorl, 18 mm.; length of the aperture, including the canal, 23 mm.

Type:—No. 218, and cotypes Nos. 219, 220, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Drillia temblorensis, new species

Plate 7, figures 5a and 5b.

Shell small, fusiform, with seven or eight whorls; spire high with an acute apex; whorls angulated a little in front of the middle, flat above, convex below, sculptured with ten or eleven fine spiral cords which are crossed by numerous lines of growth; six spiral cords above the angle and four below, two of the latter slightly more prominent than those intervening; suture distinct, channeled; body-whorl with twenty-four spiral cords, those near the shoulder most prominent; aperture elliptical, with a simple outer lip; canal moderately short; columella smooth and twisted.

Dimensions:—Altitude of the type specimen, 13.5 mm.; maximum diameter of the last whorl, 5.5 mm.

Type:—No. 221, and cotype No. 222, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 64, in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Drillia temblorensis resembles *Drillia inermis* Hinds, in having almost no axial ribs, and in having an ornamentation consisting chiefly of revolving lines. It may be distinguished from the latter by its fine axial ornamentation, few spiral cords, less distinct suture, and less angulated whorls.

Drillia bulwaldana, new species

Plate 7, figures 3a, 3b, and 3c.

Shell small, slender, solid, with eight to ten whorls; spire high, with an acute apex; whorls angulated a little above the middle producing prominent shoulders, very concave above, convex below, each whorl crossed by thirteen strong, rounded axial ribs with slightly wider interspaces, and numerous fine spiral threads of unequal size, three or four on each whorl more prominent than those intervening; the latter very fine, and scarcely raised, making the surface appear to be spirally striate; suture distinct, wavy, bordered below by a sutural collar about one-half millimeter in width; body-whorl with ten or twelve major spiral threads, slightly concave on the posterior portion, strongly nodose on the shoulder; aperture oval; canal short; columella incrusted; posterior sinus deep and narrow, between the suture and the angle.

Dimensions:—Altitude of the type specimen, 21 mm.; diameter of the last whorl, 7 mm.

Type:—No. 223, and cotypes Nos. 224 and 225, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 68.

Drillia buwaldana somewhat resembles *Drillia montereyensis* Stearns but is larger, with less conspicuous sutural collar, more distinct whorls, longer canal, and few and more prominent axial ribs.

Named in honor of Mr. J. P. Buwalda.

Drillia antiselli, new species

Plate 7, figures 2a and 2b.

Shell small, solid, rather broadly fusiform; spire high with an acute apex; whorls six or seven, angulated a little in front of the middle, concave above, convex below, marked with four spiral lines, one on the angle and three below; suture distinct; body-whorl with ten or eleven spiral lines in front of the shoulder; aperture elliptical, with simple outer lip; canal short and broad, slightly recurved; columella incrusted, smooth, with anterior sulcus.

Dimensions:—Altitude of the type specimen, 17.5 mm.; diameter of the last whorl, 7.5 mm.; length of the aperture, including the canal, 9 mm.

Type:—No. 226, and cotype No. 227, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon, 1¼ miles northeast of Barker's ranch house.

Named in honor of Dr. Thomas Antisell.

Drillia ocoyana, new species

Plate 7, figures 1a and 1b.

Shell small, elongate, solid, with seven or eight whorls; spire elevated; whorls slightly convex or nearly flat, sculptured with numerous spiral grooves eight on the whorls of the spire and about twenty-five on the body-whorl; the interspaces between the spiral grooves on the body-whorl slightly raised and often divided by a small intercalary groove; numerous faint axial lines are visible on the upper whorls of some specimens; suture strongly appressed; body-whorl sharply rounded on the anterior margin, and angulated near the posterior margin on some specimens, concave above, broadly convex below; aperture elliptical, oblique, with an arcuate outer lip and a shallow posterior sinus; canal very short; columella concave, incrusted, with an umbilical chink.

Dimensions:—Altitude of the type specimen, 22 mm., with the first few whorls broken; diameter of the last whorl, 10 mm.; length of the aperture, including the canal, 10 mm.

Type:—No. 228, and cotype No. 229, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 64, in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Drillia columbiana, new species

Plate 7, figures 4a and 4b.

Shell fusiform, small, with six or seven whorls; spire high, with an acute apex; whorls angulated a little below the middle, concave above with very fine spiral striations, flat below with two or three spiral threads, crossed by axial lines of growth; suture distinct, channeled; body-whorl convex in front of the shoulder, sculptured with nine or ten spiral threads having slightly wider interspaces which occasionally contain very fine intercalary lines; the spiral threads replaced by seven or eight striations on the anterior portion of the body-whorl; aperture ovate, with simple outer lip; canal short; columella twisted; posterior sinus broad and moderately deep.

Dimensions:—Altitude of the type, with defective apex, 9 mm.; diameter of the last whorl, 4.5 mm.

Type:—No. 231, and cotype No. 232, Cal. Acad. Sci., Oligocene(?) (or Miocene?) of northwestern Oregon.

Genus MANGILIA Risso

Mangilia kernensis, new species

Plate 7, figures 6a and 6b.

Shell slender and small, fusiform, with seven or eight whorls, spire high with an acute apex; whorls angulated a little above the middle, concave above, convex below, sculptured with twelve to fourteen axial ribs and about ten spiral threads, five of moderate size below the angle and four or five very fine spiral lines above the angle; axial ribs most prominent below the angle and rising to small nodes on the shoulder; interspaces equal in width to the ribs and frequently carrying intercalary lines; suture distinct, appressed; body-whorl ornamented with ten to twelve spiral threads between which are secondary spiral lines; aperture elliptical, with a simple outer lip; columella slightly incrusted, straight; canal short, posterior sinus deep and narrow, near the suture.

Dimensions:—Altitude of the type, 6 mm.; diameter of the last whorl, 2 mm.

Type:—No. 233, and cotype No. 234, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Mangilia howei, new species

Plate 7, figure 7.

Shell small, fusiform, with five whorls; spire elevated; whorls slightly convex, crossed by seven strongly raised vertical ribs with wider interspaces; spiral sculpture consisting of fine threads which are most prominent on the anterior portion of the last whorl; aperture elliptical, with an arcuate outer lip; columella incrusted, canal short and wide.

Dimensions:—Altitude of the type specimen, 6 mm.; maximum diameter, 2.5 mm.

Type:—No. 234, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 68, on the north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house.

Genus BULLA Klein

Bulla cantuaënsis, new species

Plate 5, figures 3a and 3b.

Shell one inch or more in length, broadly elliptical, smooth or showing only regular lines of growth; aperture extending the full length of the shell, ovate in front, narrowed behind; outer lip longer than the body-whorl; umbilicus deep and narrow at the posterior end, closed or hidden anteriorly.

Dimensions:—Altitude of the type specimen, 24 mm.; diameter, 15 mm.

Occurrence:—Shells of this species are abundant in the Temblor beds just north of Cantua Creek and in beds of doubtful age west of Coalinga.

December 30, 1914.

Type:—No. 235, and cotype No. 236, Cal. Acad. Sci., from the Temblor beds one mile north of Cantua Creek, western Fresno County, California, where it is associated with *Turritella ocoyana* Conrad, *Chione temblorensis* Anderson, *Astrodapsis merriami* Anderson, and many other Temblor species.

EXPLANATION OF PLATE 1

All figures natural size

Fig. 1a. Chione panzana, new species. Type. Lower Miocene of San Luis Obispo Co., California.

Fig. 1b. Chione panzana, new species. Same locality as fig. 1a., showing the hinge plate.

Fig. 2a. Chione (Lirophora) latilaminosa, new species. Type. Exterior of left valve. Lower Miocene of Kern River, California.

Fig. 2b. The same. Dorsal view.

Fig. 2c. The same. View of hinge plate of left valve.

Fig. 3a. Cardium weaveri, new species. Oligocene(?) (or Miocene) of northwestern Oregon.

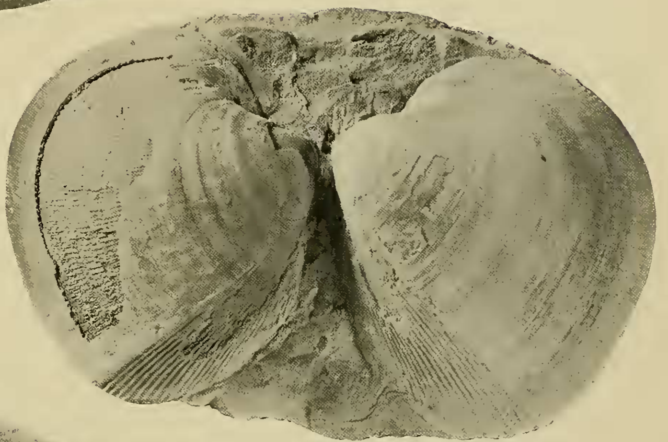
Fig. 3b. The same. Type. Same locality as fig. 3a.

1a

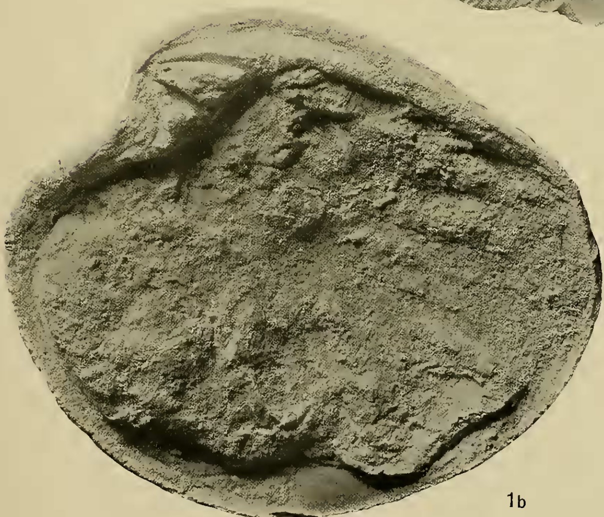
2a

2c

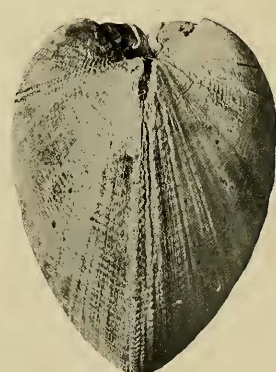
2b



3a



1b



3b

EXPLANATION OF PLATE 2

All figures natural size

Fig. 1. Chione margaritana, new species. Type. Exterior of right valve. Santa Margarita Formation of the Coalinga region, California.

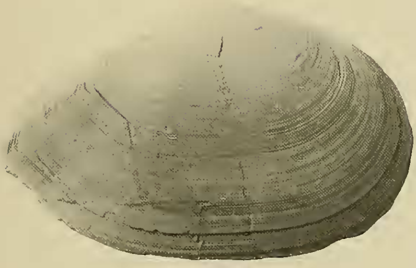
Fig. 2. Astrodapsis peltoides, new species. Type. Santa Margarita Formation of the Coalinga region, California.

Fig. 3a. Tellina nevadensis, new species. Type. Exterior of right valve. Lower Miocene of Kern River, California.

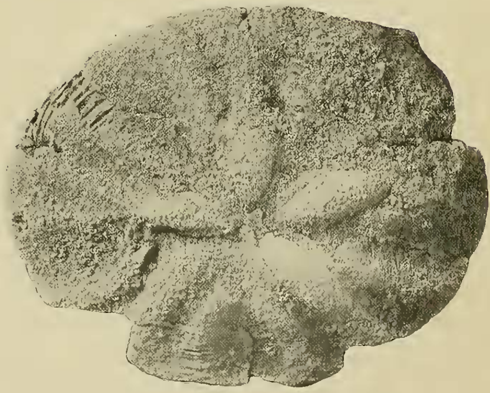
Fig. 3b. The same. Exterior of left valve. Lower Miocene of San Luis Obispo County, California.

Fig. 3c. The same. Interior of the left valve. Same locality as fig. 3a.

1



3a



2

3b

3c

EXPLANATION OF PLATE 3

Fig. 1a. Diplodonta buwaldana, new species. Natural size. Right valve. Lower Miocene of Kern River, California.

Fig. 1b. The same. Type. Natural size. Left valve. Same locality as fig. 1a.

Fig. 2. Yoldia newcombi, new species. Type. Natural size. Lower Miocene of Clallam County, California.

Fig. 3. Yoldia temblorensis, new species. Type. Natural size. Lower Miocene of Kern River, California.

Fig. 4. Semele morani, new species. Type. Natural size. Lower Miocene of San Luis Obispo County, California.

Fig. 5a. Mactra sectoris, new species. Type. Natural size. Lower Miocene of Kern River, California.

Figs. 5b, 5c, 5d, and 5e. The same. Natural size. Same locality as fig. 5a.

Fig. 6a. Transennella joaquinensis, new species. Type. ×2. Lower Miocene of Kern River, California.

Figs. 6b and 6c. The same. ×2. Same locality as fig. 6a.

Fig. 7a. Poromya gabbiana, new species. Type. Natural size. Exterior of right valve. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 7b. The same. Natural size. Same locality as fig. 7a.

Fig. 8a. Leda ochsneri, new species. Type. Natural size. Lower Miocene of Kern River, California.

Figs. 8b and 8c. The same. Natural size. Same locality as fig. 8a.

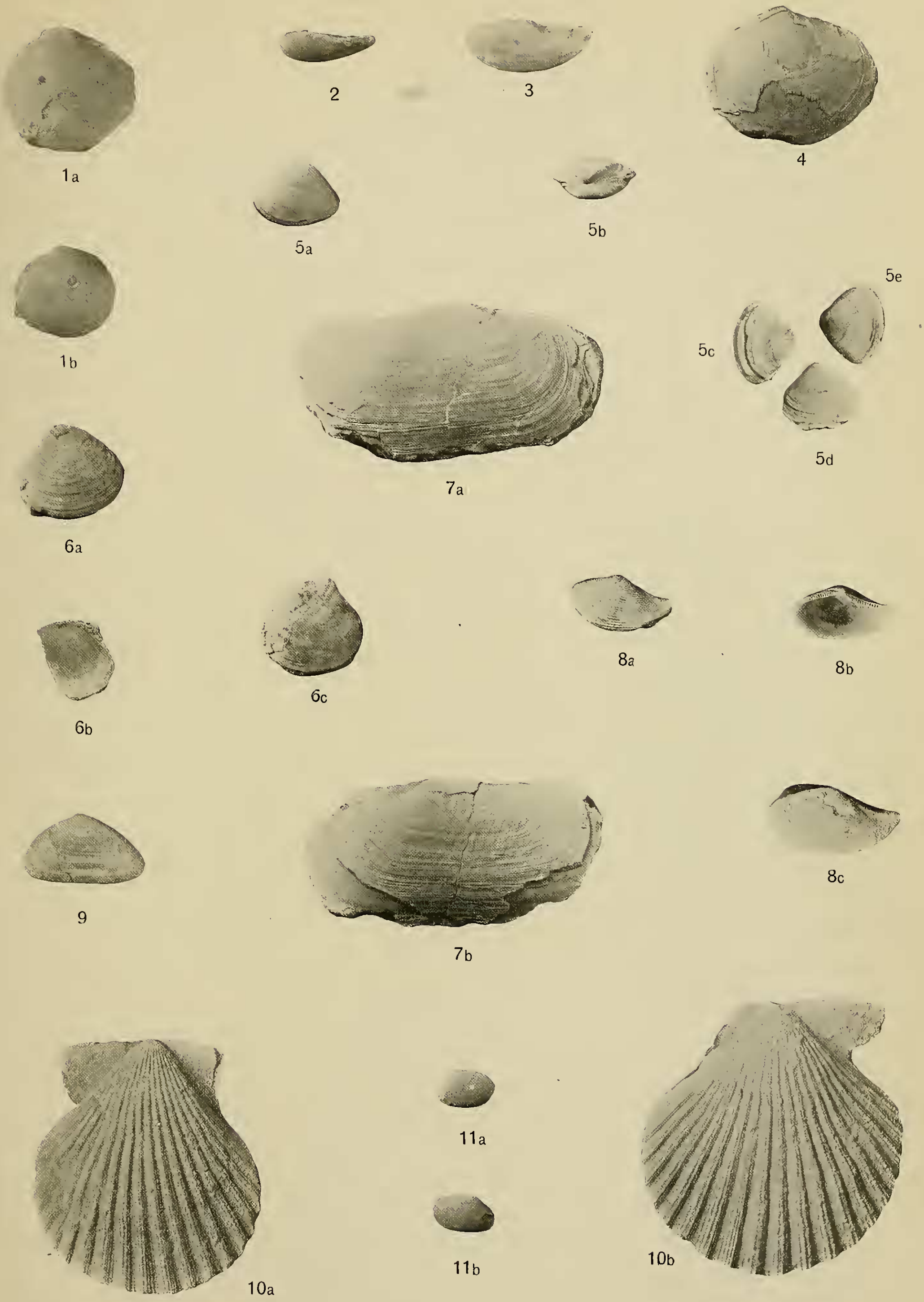
Fig. 9. Donax triangulata, new species. Type. ×2. Lower Miocene of Kern River, California.

Fig. 10a. Pecten sancti-ludovici, new species. Type. Natural size. Right valve. Middle Miocene of eastern San Luis Obispo County, California.

Fig. 10b. The same. Natural size. Showing the left valve. Same locality as fig. 10a.

Fig. 11a. Tellina wilsoni, new species. Type. Natural size. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 11b. The same. Natural size. The same locality as fig. 11a.


1a
2
3
4
5a
5b
1b
5c
5d
5e
6a
7a
6b
6c
8a
8b
9
7b
8c
10a
11a
11b
10b

EXPLANATION OF PLATE 4

All figures natural size

Fig. 1. Melongena californica, new species. Type. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 2. Siphonalia posoënsis, new species. Type. Same locality as fig. 1.

Fig. 3a. Agasoma oregonense, new species. Type. Oligocene(?) of northwestern Oregon.

Fig. 3b. Agasoma oregonense, new species. Same locality as fig. 3a.

Fig. 4. Turritella carrisaënsis, new species. Type. Middle Miocene of eastern San Luis Obispo County.

Fig. 5a. Agasoma yaquinanum, new species. Type. Miocene of the Oregon coast, four miles north of Yaquina Bay.

Fig. 5b. The same. Same locality as fig. 5a.

Fig. 6a. Chrysodomus kernensis, new species. Type. Lower Miocene of Kern River, California.

Fig. 6b. The same. Same locality as fig. 6a.

Fig. 7. Argobuccinum dilleri, new species. Type. Miocene of the Oregon coast, six miles north of Yaquina Bay.


1


2


3a

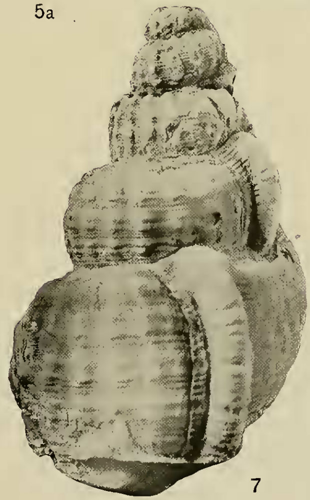

4


3b


5a


5b


6a


7


6b